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PROCEEDINGS
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1949

A REVISION OF THE GENUS PEDICULARIS IN CHINA.
PART II[1]

BY HUI-LIN LI

Research Associate, The Academy of Natural Sciences of Philadelphia,
and Harrison Fellow for Research in Botany,
University of Pennsylvania

Analytical Key to the Series of Pedicularis, Groups Allophyllum and Poecilophyllum, in China

A. Leaves opposite or verticillate; flowers opposite or verticillate, usually in terminal racemes or spikes. .... [Group I, Cyclophyllum, in Part I.]

AA. Leaves alternate, or alternate and opposite or subopposite; flowers alternate, or sometimes some subopposite, in spikes or racemes, or axillary and scattered. [Groups II, Allophyllum, and III, Poecilophyllum.]

B. Galea with long dense hairs on the margins and usually also on the dorsal surface.

C. Galea without a beak, the apex obtuse and pointed.

D. Stems usually branching at base, with radical leaves; galea more or less straight, glabrous dorsally; lower lip glabrous on the margins. .... 43. *Gloriosae*

DD. Stems simple; leaves all cauline; galea more or less bending, usually hairy dorsally; lower lip ciliate on the margins. 44. *Tristes*

CC. Galea with short or long beak, the beak conical to cylindric.

D. Beak short, conical, straight, 1-2 times as long as wide; lobes of the lower lip often with margins denticulate; anterior filaments hairy distally. ....45. *Craspedotrichae*

DD. Beak long, cylindric, straight or bending, 3-4 or more times as long as wide; lobes of the lower lip with the margins entire; all filaments glabrous (or the anterior hairy in Kialenses).

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[1] Part I of this paper appeared in these Proceedings, Vol. C, pages 205-378, Dec. 6, 1948. To the list of herbaria, with abbreviations, given on page 254, in accord with footnote 12 on page 255, is to be added that of National Taiwan University (NTU) at Taipei, Taiwan, China, where Dr. Li is now stationed.

E. Galea strongly curved, the entire dorsal side covered with dense long hairs; beak long, curved inward and pointing downward; lower lip shallowly 3-lobed, the lateral lobes reniform. .... 46. *Trichoglossae*

EE. Galea bending in the middle, glabrous or partly covered with hairs on the dorsal side; beak long, straight or slightly curved upward, more or less horizontal; lower lip deeply 3-lobed, the lateral lobes rounded or acute, not reniform.

F. Galea not twisted; beak straight or slightly bending, not sigmoid nor strongly upraised; calyx-teeth 5, similar, entire or nearly so.

G. Lower lip strongly 3-lobed nearly to the base, the lobes rounded, stipitate, the margins glabrous. 48. *Lasiophrydes*

GG. Lower lip 3-lobed to about half its length, the lobes narrow, oblong, not stipitate, the margins ciliate.

H. Beak straight, with a tuft of hairs at the apex; lobes of the lower lip equal, the middle not distad. ...... 47. *Lachnoglossae*

HH. Beak slightly bending outward, without a tuft of hairs at the apex; lobes of the lower lip unequal, the lateral shorter, the middle very distad. .... 49. *Recurvae*

FF. Galea strongly twisted; beak very long, sigmoid and strongly upraised; calyx-teeth 5, unequal, the lateral distinctly crenate, the mid-posterior small and entire. 50. *Kialenses*

BB. Galea usually glabrous or rarely slightly hairy dorsally, but without dense long hairs on the margins.

C. Galea beakless, with or without teeth near the apex, or with very short beak-like apex that bears teeth.

D. Galea without teeth near the apex.

E. Lower lip much shorter than the galea; leaves mostly opposite, rarely subopposite and alternate. .... 66. *Aloënses*

EE. Lower lip as long as, or longer than, the galea; leaves all alternate or mostly alternate, rarely opposite or subopposite.

F. Stems usually simple above, rarely branching, erect, tall; flowers subsessile or short-pedicillate, in terminal short or long spikes.

G. Stems branching; radical leaves absent; leaves twice-pinnatisect, finely dissected. 36. *Microphyllae*

GG. Stems simple; radical leaves present; leaves pinnatifid to once pinnatisect.

H. Radical leaves shorter than the stems, the cauline leaves similar to the radical but smaller; corolla-tube as long as, to twice as long as, the calyx; margins of the lower lip glabrous.

I. Leaves pinnatifid; lower lip stipitate, the middle lobe larger than the lateral, not distad. .... 39. *Tsekouenses*

II. Leaves pinnatisect, rarely pinnatifid; lower lip not stipitate, the middle lobe often smaller than the laterals and more distad. .... 51. *Hirsutae*

HH. Radical leaves as long as the stems, the cauline leaves very small, bract-like; corolla-tube twice to thrice as long as the calyx; margins of the lower lip ciliate. 67. *Pteridifoliae*

FF. Stems short to long, slender, trailing, usually branching above; flowers distinctly long-pedicillate, axillary and scattered, rarely the upper racemose.

G. Stems very short; leaves pinnatisect; flowers all axillary; galea glabrous; lower lip about as long as the galea, the lobes rounded. ..... 70. *Acaules*

GG. Stems long, branching; leaves pinnatifid; lower flowers axillary and scattered, the upper somewhat racemose; galea sparsely glandular-pilose distally; lower lip about twice as long as the galea, the lobes orbicular. .... 71. *Corydaloides*

DD. Galea with more or less distinct teeth near the apex.

E. Plants with glandular hairs on the leaves, calyces, and corollas; leaves shallowly pinnatifid, mostly radical. 40. *Hirtellae*

EE. Plants without glandular hairs; leaves pinnatisect to deeply pinnatifid, radical and cauline.

F. Stems much branched above. .... 35. *Palustres*

FF. Stems simple above.

G. Stems usually single; leaves broader, more dissected, the segments pinnatisect to pinnatifid; flowers many; corolla-tube usually twice as long as the calyx.

H. Leaves all cauline; inflorescences racemose. 31. *Striatae*

HH. Leaves radical and cauline; inflorescences spicate.

I. Leaves deeply pinnatifid, the segments pinnatifid. .... 32. *Sudeticae*

II. Leaves once or twice pinnatisect. 33. *Comosae*

GG. Stems usually many, clustered; leaves narrow, less dissected, the segments serrate; flowers few; corolla-tube slightly exceeding the calyx in length. 52. *Rhynchodontae*

CC. Galea distinctly short or long-beaked; usually without teeth, these never near apex.

D. Corolla-tube short to about twice as long as the calyx, enlarged distally.

E. Stems long or short, usually slender and trailing; leaves alternate but frequently also opposite or subopposite; flowers axillary, scattered, usually very long- and slender-pedicillate, rarely short-pedicillate and clustered.

F. Radical leaves very large, fern-like, pinnatisect, the cauline much smaller, pinnatifid; flowers short-pedicillate and clustered. .... 69. *Vagantes*

FF. Radical and cauline leaves similar and of the same size or the cauline sometimes slightly smaller, all pinnatisect; flowers lone-pedicillate and scattered.

G. Plants tall; calyx not cleft anteriorly or very slightly so, 5-dentate.

H. Stems soft, fleshy; flowers more or less grouped toward the apex of the stems; beak conical. .... 72. *Infirmae*

HH. Stems very slender, not fleshy; flowers scattered throughout the whole length of the stem; beak more or less cylindric. 73. *Longipedes*

GG. Plants low; calyx deeply cleft anteriorly, 2-3-, rarely 5-dentate.

H. Corolla-tube short, scarcely exceeding the calyx in length. .... 77. *Franchetianae*

HH. Corolla-tube long, cylindric, 2-2½ times as long as the calyx. .... 78. *Wilsoniae*

EE. Stems erect or ascending; leaves alternate, rarely also opposite; flowers in inflorescences terminating the stems, short-, rarely long-pedicillate.

F. Inflorescences very short, in compact racemes or spikes, sometimes subcapitate.

G. Radical leaves very large and very long-petiolate; corolla-tube enlarged distally... 68. *Phaceliaefoliae*

GG. Radical leaves none or few, and when present as large as, or slightly larger than, the cauline; corolla-tube only slightly enlarged distally. 58. *Oliganthae*

FF. Inflorescences usually long, in elongated compact or lax spikes or racemes.

G. Leaves shallowly to deeply crenate, not pinnatifid nor pinnatisect.

H. Leaves thick, carnose to chartaceous, often sessile to very short-petiolate; calyx-teeth serrate, rarely subentire; beak very short, conical. .... 41. *Carnosae*

HH. Leaves thin, membranaceous to chartaceous, often petiolate, sometimes sessile; calyx-teeth entire, rarely dentate; beak long, conical. .... 42. *Racemosae*

GG. Leaves pinnatisect to deeply pinnatifid.

H. Leaves mostly cauline, usually very many.

I. Galea with a short conical beak, the beak rarely short-filiform.

J. Inflorescences many-flowered, compact; calyx cleft anteriorly.

K. Corolla-tube usually bending; calyx-teeth deltoid, entire. 34. *Compactae*

KK. Corolla-tube erect; calyx-teeth broad to rounded, incised-serrate. .... 36. *Microphyllae*

JJ. Inflorescences few- to many-flowered, lax; calyx not cleft anteriorly. 61. *Talienses*

II. Galea with a distinct slender filiform beak.

J. Galea not twisted.

K. Lower lip of the corolla large, as long as the upper; beak straight or slightly bending downward; calyx cleft anteriorly.

L. Leaves with subentire to serrate segments; calyx-teeth 5.

M. Leaves short-petiolate, small; middle lobe of the lower corolla-lip much smaller than the lateral and hardly distad.
38. *Polyphyllatae*

MM. Leaves long-petiolate, large; middle lobe of the lower corolla-lip subequal to the laterals and more or less distad.
37. *Furfuraceae*

LL. Leaves with pinnatifid segments; calyx-teeth usually 3, rarely 5.
63. *Oxycarpae*

KK. Lower corolla-lip small and short, scarcely ⅓ as long as the upper; beak bending upward; calyx scarcely cleft anteriorly.
62. *Subsurrectae*

JJ. Galea strongly twisted to one side.

K. Pedicels short, usually shorter than the calyx. 63. *Oxycarpae*

KK. Pedicels very long, longer than the flower. .... 64. *Dissectae*

HH. Leaves mostly radical, many or few, the cauline none, or when present usually few.

I. Corolla-tube as long as, to less than twice the length of, the calyx.

J. Flowers medium-sized; calyx not cleft or slightly cleft anteriorly, with 5 teeth; corolla-tube as long as, or usually longer than, the calyx; beak more or less straight; leaves pinnatisect to deeply pinnatifid; cauline leaves absent or present.

K. Cauline leaves absent; leaves mostly pinnatisect; beak short, conical-filiform.

L. Plant very low; leaves with 5-7 segments on each side; inflorescences shorter, few- (to 6-8) flowered.
53. *Asplenifoliae*

LL. Plant taller; leaves with 10-15 segments on each side; inflorescences longer and more numerously flowered. .. 54. *Filiculae*

KK. Cauline leaves present but few; pinnatifid; beak longer and more slender. 55. *Paucifoliatae*

JJ. Flowers very large; calyx usually cleft anteriorly, with 2-3, rarely 5, teeth; corolla-tube about as long as the calyx; beak curved; leaves deeply pinnatifid; cauline leaves usually present. ... 65. *Macranthae*

II. Corolla-tube twice or more than twice as long as the calyx.

J. Both the corolla-tube and the lower part of the galea erect; galea with reflexed teeth on the margins; beak subfiliform, straight, slightly bifid at tip. .... 60. *Amplitubae*

JJ. Corolla-tube bending slightly distally at the junction of the galea; galea without reflexed teeth; beak long, slender, sigmoid to strongly curved, entire at the apex.

K. Lower lip large and broad, much longer than the galea, the middle lobe slightly distad. 59. *Rhinanthoides*

KK. Lower lip very small, shorter than the galea; the middle lobe strongly distad. 56. *Macrorhynchae*

DD. Corolla-tube long, 3-4 or more (sometimes to 15) times as long as the calyx, usually of the same caliber throughout, rarely enlarged distally.

E. Plant subacaulescent; leaves and flowers all basal; leaves simple, shallowly crenate. ....57. *Pumiliones*

EE. Plant long-caulescent; leaves often alternate and opposite on the same plant, pinnatifid to pinnatisect; flowers long or short-pedicillate, axillary and scattered.

F. Stems long, slender, trailing; flowers with longer and more slender pedicels which are usually longer than the flowers; calyx cleft anteriorly, 5-dentate.

G. Leaves alternate to opposite or subopposite, less dissected, the segments broad, shallowly pinnatifid to serrate; galea without teeth on the lower margins.

H. Radical and cauline leaves dissimilar, the radicals much larger, pinnatisect, the cauline much smaller, pinnatifid. .... 74. *Omiianae*

HH. Radical and cauline leaves similar, the radicals sometimes slightly larger, all pinnatisect. .... 75. *Muscicolae*

GG. Leaves nearly all opposite or subopposite, much dissected, the segments narrow and deeply pinnatifid; galea with two teeth on the lower margins. .... 76. *Batangenses*

FF. Stems usually short, erect or spreading; flowers with short or rarely long pedicels, these shorter than the flowers, axillary, more or less grouped toward the distal part of the stems; calyx cleft anteriorly, 2-3-, rarely 5-dentate. .... 79. *Longiflorae*

GREX II. ALLOPHYLLUM

Strictae; foliis alternis; inflorescentiis terminalibus, racemosis vel spicatis; floribus alternis, sessilibus vel breviter petiolatis, raro longe petiolatis.

SECTIO X. APOCLADUS. Elatae, rigidae, simplices; foliis plerumque pinnatisectis, segmentis pinnatifidis vel pinnatisectis; inflorescentiis longis, densis, multifloris; calyce 5-dentato; galeā breviter rostratā et bidentatā vel distincte rostratā et edentatā.

Series 31. Striatae. Folia caulina, pinnatisecta, segmentis pinnatifidis vel dentatis; inflorescentiis racemosis; calyce haud fisso; corollae tubo recto; galeā apice dentatā. (Species 110, figure 89.)

Series 32. Sudeticae. Folia radicalia caulinaque, pinnatifida, lobis pinnatifidis; inflorescentiis spicatis; calyce haud fisso; corollae tubo recto; galeā breviter rostratā, bidentatā. (Species 111, figure 90.)

Series 33. Comosae. Folia radicalia caulinaque, pinnatisecta vel bipinnatisecta; inflorescentiis spicatis; calyce haud fisso; corollae tubo recto; galeā apice breviter rostratā, bidentatā. (Species 112-124, figures 91-100.)

Series 34. Compactae. Folia radicalia caulinaque, pinnatifida vel pinnatisecta, lobis serratis; calyce fisso; corollae tubo interdum curvato; galeā distincte rostratā; rostro conico. (Species 125, figure 101.)

SECTIO XI. CLADOMANIA. Elatae, valde ramosae; foliis pinnatifidis vel pinnatisectis; floribus breviter laxeque racemosis; calyce fisso, bidentato; galeā valde breviter rostratā, bidentatā.

Series 35. Palustres. Flores breviter pedicellati; galeā rectā; labio inferiore 3-lobato, lobis inaequalibus, rotundatis. (Species 126-127, figures 102-103.)

SECTIO XII. PHYLLOMANIA. Elatae; foliis plerumque caulinis, multis, parvis raro grandibus, pinnatifidis vel pinnatisectis, breviter vel longe petiolatis; inflorescentiis brevibus, compactis.

Series 36. Microphyllae. Ramosae; foliis plerumque parvibus, sessilibus vel petiolatis; corollae tubo recto vel leviter curvato; galeā rostratā vel haud rostratā; rostro conico vel breviter filiformi; labio inferiore inaequaliter 3-lobato, lobo medio minore, vix porrecto. (Species 128-130, figures 104-106.)

Series 37. Furfuraceae. Strictae; foliis grandibus, longe petiolatis; corollae tubo recto; galeā distincte longe rostratā; rostro filiformi; labio inferiore inaequaliter 3-lobato, lobo medio valde minore, vix porrecto. (Species 131-134, figures 107-108.)

Series 38. Polyphyllatae. Folia parva, breviter petiolata; corollae tubo recto; galeā longe rostratā; rostro gracili, filiformi; labio inferiore subaequaliter 3-lobato, lobo medio plus minusve porrecto. (Species 135-140, figures 109-112.)

SECTIO XIII. HAPLOPHYLLUM. Elatae, strictae, simplices vel ramosae; foliis radicalibus caulinisque, leviter pinnatifidis vel crenatis; inflorescentiis longis vel brevibus.

Series 39. Tsekouenses. Simplices; foliis caulinis paucis, leviter pinnatifidis; inflorescentiis breviter spicatis; galeā apice obtusā, integrā; labio inferiore longe stipitato. (Species 141, figure 113.)

Series 40. Hirtellae. Simplices, glandulari-hirsutae; foliis plerumque radicalibus, leviter pinnatifidis; inflorescentiis longe racemosis; galeā apice distincte bidentatā; labio inferiore brevi, haud stipitato. (Species 142, figure 114.)

Series 41. Carnosae. Simplices vel ramosae; foliis leviter vel profunde crenatis, carnosis vel chartaceis, sessilibus vel valde breviter petiolatis; inflorescentiis longe denseque spicatis; calycis dentibus serratis, raro subintegris; galeā distincte rostratā; rostro breviter conico. (Species 143-150, figures 115-120.)

Series 42. Racemosae. Simplices vel ramosae; foliis caulinis, leviter vel profunde crenatis, membranaceis vel chartaceis, petiolatis, interdum sessilibus; inflorescentiis spicatis; calycis dentibus integris, raro dentatis; galeā distincte rostratā; rostro longe conico. (Species 151-152, figures 121-122.)

SECTIO XIV. LASIOGLOSSA. Elatae, strictae, simplices vel pluricaules; foliis radicalibus caulinisque, caulinis plerumque sessilibus, crenato-pinnatifidis, raro pinnatisectis; galeā margine longe denseque hirsutā, fronte plerumque villosā vel hirsutā.

Series 43. Gloriosae. Pluricaules; foliis radicalibus caulinisque; galeā plus minusve rectā, fronte glabrā, apice obtusā vel acutā; labio inferiore glabro. (Species 153-155, figures 123-124.)

Series 44. Tristes. Simplices; foliis omnino caulinis; galeā plus minusve curvatā, fronte plerumque pubescente, apice obtusā vel acutā; labio inferiore plerumque ciliato. (Species 156-164, figures 125-133.)

Series 45. Craspedotrichae. Simplices; galeā breviter rostratā; rostro conico, recto; labio inferiore plerumque denticulato; filamentis anterioribus ad apicem villosis. (Species 165-173, figures 134-139.)

Series 46. Trichoglossae. Simplices; galeā valde curvatā, fronte dense longeque villosā, apice rostratā; rostro longo, cylindrico, valde incurvato; labio inferiore leviter 3-lobato, lobis lateralibus reniformibus; filamentis glabris. (Species 174-175, figures 140-141.)

Series 47. Lachnoglossae. Simplices; galeā ad medium curvatā, apice rostratā; rostro longo, cylindrico, recto, apice dense hirsuto; labio inferiore ad medium 3-lobato, lobis angustis, oblongis, ciliatis, lobo medio haud porrecto. (Species 176, figure 142.)

Series 48. Lasiophrydes. Simplices; galeā ad medium curvatā, apice rostratā; rostro longo, cylindrico, plus minusve recto; labio inferiore profunde 3-lobato, lobis rotundatis, glabris, stipitatis; filamentis glabris. (Species 177-178, figures 143-144.)

Series 49. Recurvae. Simplices; galeā ad medium curvatā, apice rostratā; rostro longo, cylindrico, leviter curvato; labio inferiore angusto, lobis inaequalibus, lobis lateralibus brevioribus, lobo medio conspicue porrecto; filamentis glabris. (Species 179-180, figures 145-146.)

Series 50. Kialenses. Pluricaules; galeā ad medium curvatā, valde tortā, apice rostratā; rostro longo, sigmoideo, sublevato; filamentis anterioribus ad apicem villosis. (Species 181, figure 147.)

Sectio XV. Rhizophyllum. Humiles et elatiores; radicibus fasciculatis, plerumque carnosis; foliis plerumque radicalibus, multis, longe petiolatis, pinnatisectis vel pinnatifidis, raro crenatis, caulinis paucis vel nullis; inflorescentiis longis vel brevibus; calyce haud vel leviter fisso, 5-dentato.

Series 51. Hirsutae. Humiles; foliis pinnatisectis raro pinnatifidis, plerumque radicalibus; corollae tubo calycem aequante vel sublongiore; galeā apice subacutā vel rotundatā, edentatā. (Species 182-187, figures 148-151.)

Series 52. Rhynchodontatae. Humiles; foliis pinnatisectis, plerumque radicalibus; corollae tubo calycem subsuperante; galeā apice acutā vel truncatā, obscure vel distincte dentatā. (Species 188-191, figures 152-155.)

Series 53. Asplenifoliae. Humiles; foliis radicalibus, caulinis nullis, plerumque pinnatisectis, segmentis 5-7-jugis; inflorescentiis brevibus, paucifloris; corollae tubo calycem ad duplo longiore; galeā rostratā; rostro cylindrico-conico. (Species 192-198, figures 156-160.)

Series 54. Filiculae. Elatiores; foliis plerumque pinnatisectis, caulinis nullis, segmentis 10-15-jugis; inflorescentiis longis, multifloris; galeā longe rostratā; rostro cylindrico-conico. (Species 199-200, figures 161-162.)

Series 55. Paucifoliatae. Elatiores; foliis plerumque pinnatifidis, caulinis paucis; inflorescentiis longis vel brevibus; corollae tubo calycem aequante vel duplo longiore; galeā rostratā; rostro cylindrico-conico. (Species 201-205, figures 163-167.)

Series 56. Macrorhynchae. Elatiores; foliis plerumque radicalibus, pinnatisectis; inflorescentiis longis; corollae tubo calycem ad duplo longiore; galeā longe rostratā; rostro gracili, sigmoideo; labio inferiore parvo, galeam breviore. (Spècies 206, figure 168.)

Series 57. Pumiliones. Nanae, acaules vel subacaules; foliis plerumque basalibus, leviter crenatis vel raro integris; floribus plerumque basalibus; corollae tubo calycem 3-4-plo longiore; galeā longe rostratā; rostro filiformi, recto vel sigmoideo. (Species 207-208, figure 169.)

Sectio XVI. Botryantha. Elatiores, strictae; radicibus fasciculatis, fibrosis; foliis radicalibus et caulinis, longe petiolatis, pinnatifidis vel pinnatisectis; inflorescentiis brevibus, plerumque paucifloris; calyce profunde fisso, 2-3- vel 5-dentato.

Series 58. Oliganthae. Folia radicalia pauca; corollae tubo recto; galeā margine plerumque reflexo-dentatā, apice rostratā; rostro gracili, plus minusve recto, plerumque bifido. (Species 209-217, figures 170-176.)

Series 59. Rhinanthoides. Folia radicalia multa; corollae tubo superne leviter curvato; galeā margine haud dentatā, apice longe rostratā; rostro gracili, sigmoideo, apice integro. (Species 218-219, figures 177-178.)

Series 60. Amplitubae. Folia pinnatifida, caulinis paucis; inflorescentiis breviter racemosis; corollae tubo calycem 2-2.5-plo longiore; galeā margine reflexo-dentatā, apice rostratā; rostro subfiliformi, recto, apice subfido. (Species 220, figure 179.)

SECTIO XVII. MACROSTACHYS. Elatae, strictae; foliis plerumque caulinis, pinnatisectis vel raro pinnatifidis; inflorescentiis longe terminalibus, multifloris, plus minusve laxis; calyce integro vel fisso, 3-5-dentato.

Series 61. Talienses. Inflorescentia pauci- vel multi-flora, laxa; calyce haud fisso, dentibus 5-7; galeā haud tortā, apice rostratā; rostro brevi, conico. (Species 221, figure 180.)

Series 62. Subsurrectae. Inflorescentia longa, multiflora; galeā haud tortā, apice longe rostratā; rostro filiformi, gracili, sublevato; labio inferiore parvo, vix ⅓ longiore quam superiore. (Species 222, figure 181.)

Series 63. Oxycarpae. Inflorescentia valde longa, multiflora; calyce fisso, dentibus plerumque 3, raro 5; galeā plerumque tortā, apice rostratā; rostro longo, filiformi, plerumque curvato, interdum sigmoideo. (Species 223-229, figures 182-188.)

Series 64. Dissectae. Inflorescentia longa, multiflora; pedicellis valde longis, galeā valde tortā, apice rostratā; rostro longo, gracili, sublevato, curvato. (Species 230-232, figures 189-191.)

SECTIO XVIII. PHANERANTHA. Elatiores; foliis caulinis vel radicalibus, profunde pinnatifidis; floribus grandibus; calyce plerumque fisso, 2-3- raro 5-dentato.

Series 65. Macranthae. Pluricaules; corollae tubo calycem duplo longiore; galeā rostratā; rostro longo, curvato, apice bifido vel integro. (Species 233-235, figures 192-193.)

GROUP II. ALLOPHYLLUM

Erect, low or tall plants, the stems simple or branching; leaves alternate, simple to pinnatisect, sessile to petiolate; inflorescences terminal, spicate or racemose, the flowers alternate, sessile to short-pedicellate; corolla with a tube about as long, to twice as long, as the calyx, rarely much longer, erect or slightly bending, usually enlarged distally; galea with the apex entire, toothed, or beaked.

The kinship of the different sections and series, as well as their degree of floral modification, are graphically shown in Diagram 2.

SECTION X. APOCLADUS

Mostly tall plants; stems erect, rigid, simple; leaves radical or mostly cauline, alternate, pinnatisect or sometimes deeply pinnatifid, the segments pinnatisect to pinnatifid; flowers sessile or short-pedicellate, in long, dense, many-flowered inflorescences; calyx 5-dentate, the teeth equal or unequal, cleft or not, anteriorly; corolla with the tube slightly longer than the calyx; galea usually ending in a short, beak-like or distinctly conical-beaked apex, the apex usually bidentate; lower lip with subequal or unequal rounded lobes.

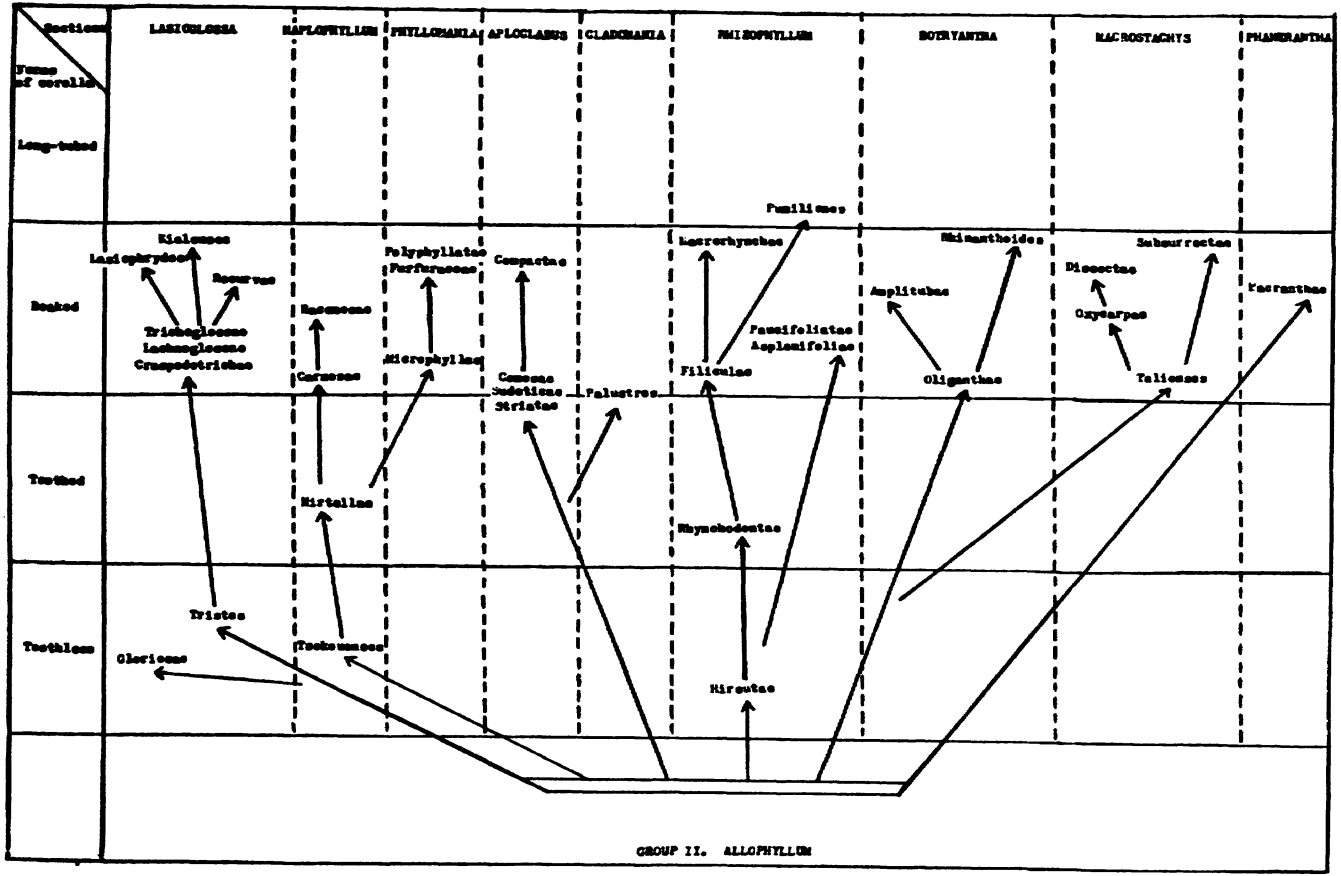


Diagram 2.—Diagram of the probable relationships and origins of the Chinese series of *Pedicularis*. Group II. Allophyllum.

The species of this section all have erect rigid simple stems, alternate, strongly dissected leaves, and long, dense more or less spicate inflorescences. The majority of the species have about the same corolla-form with a galea that is dentate and usually also short-rostrate at apex. Only in the Compactae, the beak becomes conical and distinct. This section is evidently one of the more primitive groups in the genus and is now more or less concentrated in the Altai-Tienshan range where the genus is supposed to have originated. Geographically this section extends from Europe through northern Asia to North America. In China, the species are found only in Sinkiang, Mongolia, and Manchuria, rarely extending farther south.

Series 31. Striatae

Striatae Maxim., in Bull. Acad. St. Pétersb., 24: 81, 1878; in Mél. Biol., 10: 123, 1878.

Characters of the section.

About 3 species in North America and northern Asia. One extends to northern China (Map 15).

110. Pedicularis striata Pallas

Key to the Varieties

A. Inflorescence-rachis, bracts, and calyx glabrous; corolla yellow with reddish purple stripes. .... 110a. *P. s. typica*

AA. Inflorescence-rachis, bracts, and calyx cinereous-pubescent; corolla yellow, red or purple.

  B. Corolla yellow. .... 110b. *P. s. arachnoidea*

  BB. Corolla red or purple. .... 110c. *P. s. poliocalyx*

110a. Pedicularis striata typica Plate 23 (Part I), fig. 89.

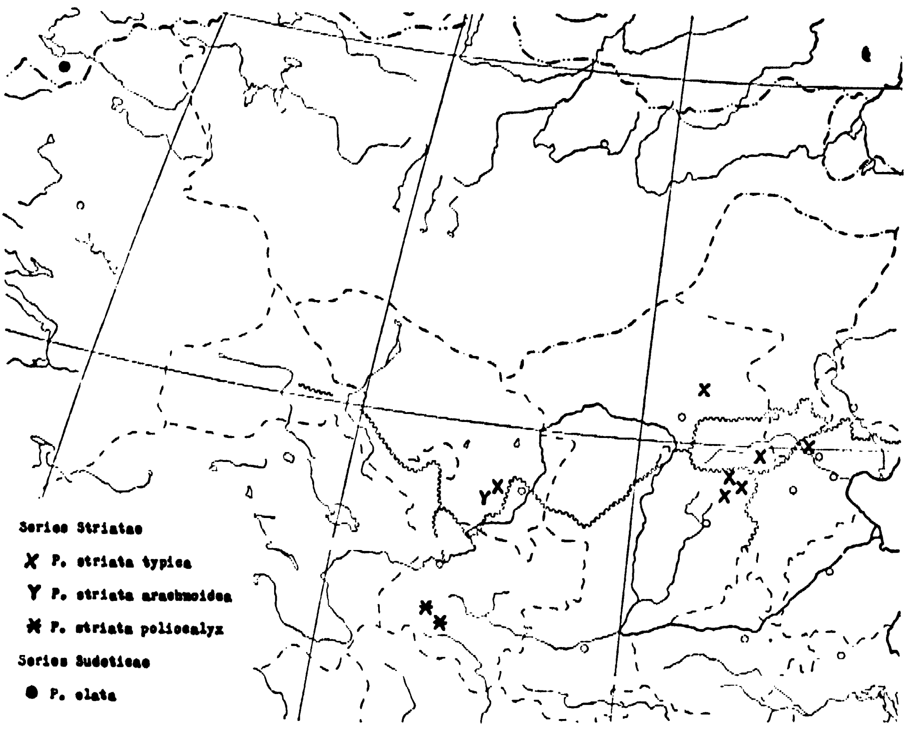
Pedicularis striata Pall., Reise, 3: 737, pl. R, fig. 2c, 1776; Franch., in Nouv. Arch. Mus. Nat. Hist. Paris, II, 6: 106, 1883 (Pl. David. I); Maxim., in Bull. Acad. St. Pétersb., 24: 82, 1878; 32: 613, fig. 159, 1888; in Mél. Biol., 10: 123, 1878; 12: 910, fig. 159, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 216, 1890; Palibin, in Act. Hort. Petrop., 14: 135, 1895; Diels, in Bot. Jahrb., 36, Beibl. 82: 97, 1905; Kamorov, in Act. Hort. Petrop., 25: 451, 1907; Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922; in Repert. Sp. Nov., 20: 215, 1924; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 220, 1934; Walker, in Contr. U. S. Nat. Herb., 28: 659, 1941. Pallas' type was from Siberia: "Prouenit in excelsis, apricis, rupestribus montium soli oppositorum; praesertim in monte Burgultei prope Kjachtam, et circa vallem Vrulungui Dauuriae lecta [Pallas]."

Alpine meadows, at altitudes of 1300 to 2650 meters, from Siberia to northern China. Flowers yellow with reddish purple stripes. Flowering in July.

MONGOLIA: northern Mongolia and Khangai, *Ikonnikov-Galitzky* 188 (NYBG), 378 (UC); east of Dozen, *Eriksson* 45 (USNH).

HOPEI: Peiping, Western Hills, *Liou* 7184 (NYBG).

SUIYUAN: Hsiao Wutaishan, *C. F. Li* 10855 (NYBG), *J. C. Liu* 1881 (UC); Hala-ching-kow, Tatsingshan, *Hsia* 2814 (NYBG).



Map 15.—Distribution of the series Striatae and Sudeticae.

SHANSI: Yang-chia-ping, *Schindler* 21 (ANSP, UCLA); Chin-yuan, *K. Ling* 9243 (UC), 9364 (UC); Tung-tsai, *Lowdermilk* 5509 (UC), *Lowdermilk & Lee* 5588 (UC); Tsin-lian-shih, near Mt. Wu-tai, *Tang* 1074 (NYBG).

NINGHSIA: Ho-lan-shan, *Ching* 1066 (USNH).

110b. **Pedicularis striata arachnoidea** Franchet

Pedicularis striata Pall. var. *arachnoidea* Franch., in Nouv. Arch. Mus. Hist. Nat. Paris, II, 6: 106, 1883 (Pl. David. I). The type, "Mongolia: hautes montagnes de l'Ourato; ([David] 2788)," has not been seen. According to Bretschneider (History of Botanical Discoveries in China, 840, 1898), "The country of Ourato (Oirat Mongols), Ou la in Chinese, is situated west of the Tu mets and borders westward on the principality of Ala Shan." Ala Shan or Ho-lan Shan is in the eastern part of Ninghsia province formerly of Inner Mongolia.

In Ninghsia. Corolla yellow. Known from the original collection only. No specimen seen.

This variety has yellow corolla like the typical form of the species but it differs in having densely pubescent calyces and bracts. It is possible that Diels' var. *poliocalyx* is the same as var. *arachnoidea;* they differ from each other, as described, only in the color of the corolla. The corolla of var. *arachnoidea* was described as yellow and that of var. *poliocalyx* as red or purple. In the typical form of the species, the corolla is yellow but with reddish-purple stripes, which may also be the case in both varieties.

110c. **Pedicularis striata poliocalyx** Diels

Pedicularis striata Pall. var. *poliocalyx* Diels, in Notizbl. Bot. Gart. Berlin, 10: 892, 1930; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 34, 1933. Diels originally cited: "China boreali-occidentalis: Prov. Kansu, T'ao-River basin, 'on the river east of Choni,' 2400 m.s.m. (fl. Juni-Juli 1925—Rock n. 12798—Typus varietatis!); 'Alpine meadows of Toyü ku' 2900 m.s.m. (fl. Juli 1925—Rock n. 12916)." Isotypes are in the Gray Herbarium and the United States National Herbarium.

In Alpine meadows at altitudes of 2440 to 2990 meters in southwestern Kansu. Flowers red or purple. Flowering in June and July.

KANSU: T'ao River basin, Toyüku, *Rock* 12916 (ANSP, GH, NYBG); T'ao River basin, east of Choni, *Rock* 12798 (ANSP, GH, USNH).

Series 32. Sudeticae

Sudeticae Maxim., in Bull. Acad. St. Pétersb., 24: 75, 1878; in Mél. Biol., 10: 114, 1878.

Tall plants; roots fascicled, fibrous, sometimes slightly thickened; stems simple, erect; leaves radical or mostly cauline, mostly deeply pinnatifid, the lobes lanceolate, pinnatifid to serrate; flowers in dense, elongate spikes; calyx campanulate, 5-dentate, the teeth equal, entire to serrulate; corolla purple; tube erect, longer than the calyx; galea erect, very shortly rostrate at the apex, 2-dentate; lower lip 3-lobed, the lobes rounded, glabrous on the margins; 2 of the staminal filaments hairy.

About 10 species from northern Europe to Siberia and northern North America. One species extends to the Dzungaria basin in Sinkiang (Map 15).

In addition to *P. elata* there is *P. songarica* Schrenk[2] found in Dzungaria Alatau and included by Limpricht in the series Comosae. This species, as indicated by Maximowicz, is intermediate between the two series, Sudeticae and Comosae. It is probably rather closely related to *P. physocalyx* Bunge. Prain (in Ann. Bot. Gard. Calcutta, 3: 87, 1879) separated *P. elata* Willd. from other species of the series Sudeticae to form a separate series of its own, "Elata."

111. **Pedicularis elata** Willdenow Plate 23 (Part 1), fig. 90.

Pedicularis elata Willdenow, Sp. Pl., 3: 210, 1800; Maxim., in Bull. Acad. St. Pétersb., 24: 76, 1878; 32: fig. 141, 1888; in Mél. Biol., 10: 115, 1878; 12: fig. 141, 1888; Limpricht, in Repert. Sp. Nov., 20: 217, 1924. The type was from Siberia: "Habitat in Sibiriae agris ad fluvium Cataham."

Alpine regions from Siberia to Dzungaria. Flowers purple. Flowering in June.

DZUNGARIA: *Schrenk* s.n. (USNH); Dzungaria, Lake Saisang-nor, *Fischer* s.n. (ANSP, NYBG).

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[2] *Pedicularis songarica* Schrenk, in Bull. Acad. St. Pétersb., 1: 79, 1842; in Fischer & Meyer, Enum. Alt. Pl. Nov. Schrenk, 2: 25, 1842; Benth., in DC. Prodr., 10: 571, 1846; Limpricht, in Repert. Sp. Nov., 20: 217, 1924. The type was from Dzungaria: "Lecta in montibus Dshabyk, d. 10-11 Julii m." In mountains of Dzungaria. Flowers yellowish. No specimen seen.

Series 33. Comosae

Comosae Maxim., in Bull. Acad. St. Pétersb., 24: 77, 1878; in Mél. Biol., 10: 116, 1878.

Tall, rarely low plants; roots fascicled, fibrous, usually slightly thickened; stems simple, erect; leaves radical and cauline, oblong-lanceolate, pinnatisect or sometimes deeply pinnatifid, the segments pinnatisect to pinnatifid; flowers in more or less dense spikes, usually elongated; calyx campanulate, 5-dentate, the teeth equal to unequal, deltoid to oblong or ovate, entire to distinctly serrate; corolla purple or yellow to whitish; tube erect, longer than the calyx; galea erect, more or less distinctly or shortly rostrate at apex, 2-dentate; lower lip as long as the galea to either slightly longer or much shorter, the lobes rounded, ciliate or glabrous on the margins; 2 of the staminal filaments hairy or all filaments glabrous.

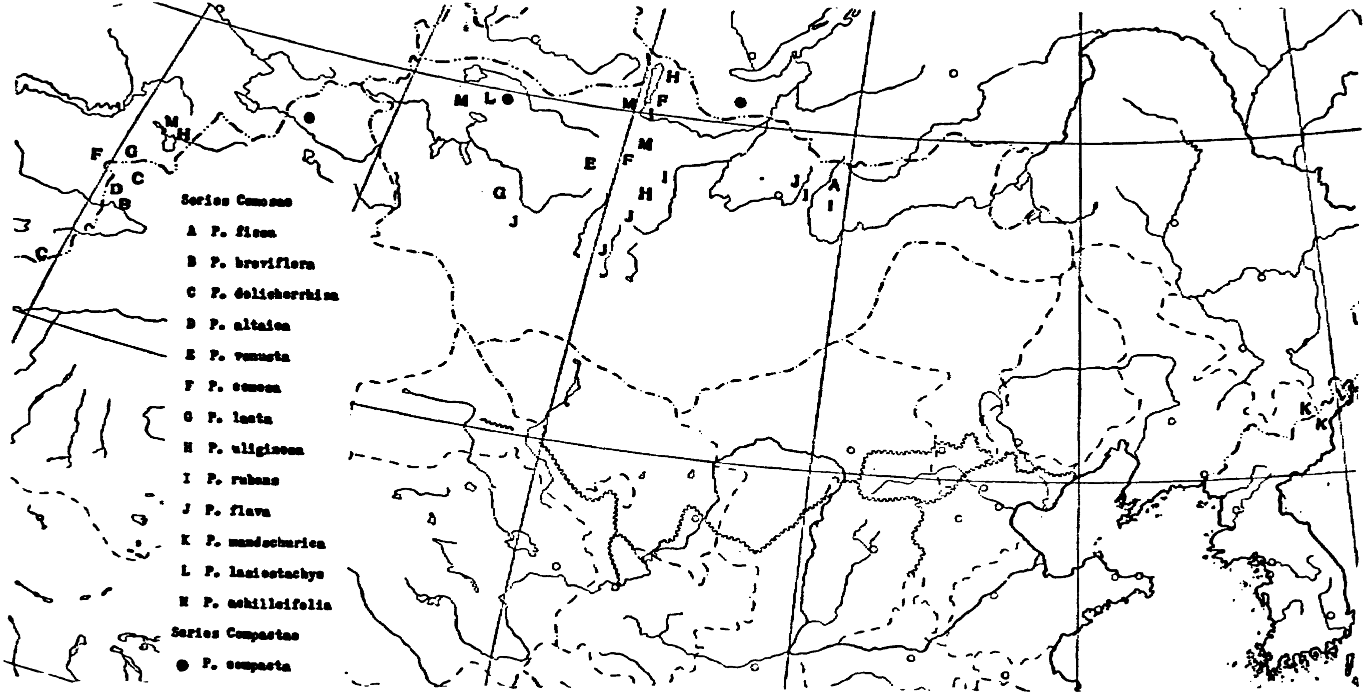
About 30 species widely distributed in Europe and northern Asia. About 13 species are found in Dzungaria and northern Mongolia with one of them in Manchuria (Map 16).

This series is very close to the series Sudeticae, with *P. songarica* Schrenk apparently intermediate between the two. The series is characterized by the leaves being simple to bi-pinnatisect or deeply pinnatifid, the stems elongated and foliate, and the spikes elongated. The galea is either shortly or distinctly rostrate. This series is also closely related to the series Compactae, but the latter has more distinct and elongated beak and has no teeth.

Among the species enumerated below there are some reported from China but of which I have seen no Chinese specimens. In such cases plants collected from Dzungaria on the Russian border are cited whenever observed.

Key to the Chinese Species

A. Calyx-teeth deltoid, entire, equal to subequal, almost as long as broad.
  B. Flowers purple; calyx distinctly cleft anteriorly; lower lip as long as the galea; all staminal filaments glabrous. .... 112. *P. fissa*
  BB. Flowers yellow or white (corolla-color unknown in *P. breviflora*); calyx not cleft anteriorly or only very slightly so; lower lip usually shorter than the galea or sometimes almost as long; 2 of the staminal filaments hairy.
    C. Corolla short, only 14 mm. long; lower lip longer than the galea. 113. *P. breviflora*
    CC. Corolla long, 18-25 mm. or more long; lower lip as long as or shorter than the galea.
      D. Beak distinct, longer than broad; lower lip almost as long as the galea; bracts trifid. .... 114. *P. dolichorrhiza*
      DD. Beak very short, broader than long or almost none; galea much longer than the lower lip; bracts trifid to linear-lanceolate.
        E. Bracts broad, trifid; calyx more or less reticulate; corolla smaller, 18-22 mm. long.
          F. Beak almost none; calyx densely canescent-pubescent; corolla about 18-20 mm. long. .... 115. *P. altaica*
          FF. Beak broad, short; calyx glabrate to slightly pubescent, ciliate along the margins only; corolla about 22 mm. long. .... 116. *P. venusta*



Map 16.—Distribution of the series Comosae and Compactae.

EE. Bracts linear-lanceolate; calyx sparsely reticulate; corolla longer, about 25 mm. long. .... 117. *P. comosa*

AA. Calyx-teeth lanceolate to spatulate, much longer than broad, subequal to unequal, the posterior one often smaller and nearly deltoid.

B. Flowers purple.

C. Bracts narrower, entire; calyx-teeth subequal, entire; lower lip slightly shorter than the galea. .... 118. *P. laeta*

CC. Bracts broader, palmatifid; calyx-teeth unequal, subentire to distinctly serrate, the posterior one often smaller and entire; lower lip as long as or slightly longer than the galea.

D. Leaf-segments broadly ovate-oblong, pinnatifid to serrate; calyx-teeth oblong, distinctly serrate; galea distinctly beaked, the beak longer than broad. .... 119. *P. uliginosa*

DD. Leaf-segments linear-oblong, pinnatisect to deeply pinnatifid; calyx-teeth subulate, subentire to obscurely serrate; galea very shortly beaked. .... 120. *P. rubens*

BB. Flowers white or yellow.

C. Lower lip of the corolla slightly longer than the galea; bracts trifid to foliaceous; calyx not reticulate or only slightly so, the teeth profoundly serrate.

D. Bracts usually trifid; calyx densely pubescent, without reticulation or very slightly reticulate. .... 121. *P. flava*

DD. Bracts foliaceous, serrate; calyx glabrous or nearly so, more or less sparsely reticulate. .... 122. *P. mandshurica*

CC. Galea longer than the lower lip of the corolla; bracts linear, entire to serrate; calyx more or less densely reticulate; the teeth entire to serrate.

D. Calyx-teeth and bracts serrate. .... 123. *P. lasiostachys*

DD. Calyx-teeth and bracts entire. .... 124. *P. achilleifolia*

112. **Pedicularis fissa** Turczaninow Plate 23 (Part I), fig. 91.

Pedicularis fissa Turcz. ex Bunge, in Bull. Phys.-Math. Acad. St. Pétersb., 1: 377, 1843; Maxim., in Bull. Acad. St. Pétersb., 32: fig. 145, 1888; in Mél. Biol., 12: fig. 145, 1888; Limpricht, in Repert. Sp. Nov., 20: 218, 1924. The types were from Siberia: "Hab. in alpibus baikalensibus ad fontes fl. Wydrinka (B[unge] !) et dauricis (Turcz[aninow] !)." A duplicate of the syntype *Turczaninow* s.n. of 1832, is in the Bonati Herbarium (ex Mus. Bot. Acad. Sci. Petrop.), to be divided between the University of California at Los Angeles and the Academy of Natural Sciences of Philadelphia.

Alpine meadows from the Baikal region in Siberia to northern Mongolia. Flowers purple.

MONGOLIA: Montes Kentei orientales ad fontes fluviorum Kerulen et Onon, *Ikonnikov-Galitzky* 679 (NYBG).

In general appearance as well as in floral structures, this species is very close to *P. rubens* from which it can be distinguished by its more anteriorly cleft calyx with short deltoid, entire teeth instead of linear-lanceolate, subentire to obscurely serrate teeth, and by its staminal filaments being all glabrous instead of the anterior ones being hairy. The inflorescences of *P. rubens* are also much more densely pubescent.

113. Pedicularis breviflora Regel

Pedicularis breviflora Regel, in Act. Hort. Petrop., 6: 352, 1879; Maxim., in Bull. Acad. St. Pétersb., 32: 612, fig. 158, 1888; in Mél. Biol., 12: 909, fig. 158, 1888; Limpricht, in Repert. Sp. Nov., 20: 221, 1924. The type was from Sinkiang: "Prope Kuldscha in montibus Sarybulak 4-6000′ alt. A. Regel specimen unicum legit." This has not been seen.

In Siberian Turkestan and in Sinkiang. Flower color unknown. No specimen seen.

This was originally briefly described. Maximowicz illustrated the plant and added descriptions but he did not incorporate the species into his key. This not fully known species might have been based on young flowers only. It suggests relationship most closely to *P. dolichorrhiza* Schrenk. The inclusion of the species and its position in the key are thus tentative.

114. Pedicularis dolichorrhiza Schrenk Plate I (Part II), fig. 92.

Pedicularis dolichorhiza Schrenk, in Bull. Phys.-Math. Acad. St. Pétersb., 1: 80, 1842; in Fisch. & Meyer, Enum. Alt. Pl. Nov. Schrenk, 2: 23, 1842; Benth., in DC. Prodr., 10: 570, 1846; Rupr., in Mem. Acad. St. Pétersb., VII, 14(4): 63, 1869; Maxim., in Bull. Acad. St. Pétersb., 32: 609, fig. 146, 1888; in Mél. Biol., 12: 905, fig. 146, 1888; Limpricht, in Repert. Sp. Nov., 20: 223, 1924. The type, "Inventa in montibus Dschabyk. d. 16 Julii m. [*Al. Schrenk*]," was from Dzungaria Alatau, along the Sinkiang-Siberian border. An isotype is in the herbarium of the Academy of Natural Sciences of Philadelphia.

Stony, alpine regions, at altitudes of about 3000 to 4000 meters, from the western Himalayas to Siberian Turkestan, northern Mongolia and Sinkiang. Flowers yellow.

SINKIANG: Ad lac. Sairam, *Fetissow* s.n. (GH).

A study of the type specimens shows that the beak is rather long and distinct, longer than the case depicted by Maximowicz. The lower lip of the corolla is minutely ciliate along the margins and the calyx is almost not reticulate. The species is apparently intermediate, as indicated by the beak, between *P. comosa* and *P. compacta.*

115. Pedicularis altaica Stephan

Pedicularis altaica Steph. ex Stev., in Mem. Soc. Nat. Mosc., 6: 48, pl. 14a, 1823; Steph. ex Spreng., Syst. Veg., ed. 16, 2: 779, 1825; Benth., in DC. Prodr., 10: 570, 1846; Maxim., in Bull. Acad. St. Pétersb., 32: fig. 147, 1888; in Mél. Biol., 12: fig. 147, 1888; Limpricht, in Repert. Sp. Nov., 20: 218, 1924. Stephan's name was originally published in the synonymy of *P. comosa* by Steven and was described and depicted in a separate figure under the plate for the latter species. No specimens were cited.

Altai region in Siberia and Dzungaria.

Recorded by Limpricht (l.c.) as found in Kuldscha in Dzungaria. No specimen from Sinkiang has been seen. A specimen from the Altai region in Siberia, collected by Krylow, is in the herbarium of the Academy of Natural Sciences of Philadelphia.

116. Pedicularis venusta Schangin Plate I, fig. 93.

Pedicularis venusta Schangin ex Bunge, in Bull. Phys.-Math. Acad. St. Pétersb., 1: 380, 1843; Maxim., in Bull. Acad. St. Pétersb., 24: 80, 1878; 32: 610, fig. 148, 1888; in

Mél. Biol., 10: 121, 1878; 12: 906, fig. 148, 1888; Palabin, in Act. Hort. Petrop., 14: 135, 1895; Komarov, in op. cit., 25: 455, 1907; Limpricht, in Repert. Sp. Nov., 20: 218, 1924. The types were "Hab. in humidis subsalsis transbaicalensibus (Turcz[aninow]!) in subsalsis ad promontoria sajanensia (Schangin!) et ad Tschujam (B[unge]! Politow!) . . . v. v. sp."

Siberia to Mongolia and northern China. Flowers yellowish. Flowering in July and August.

MONGOLIA: northern Mongolia, Valley Chuang-dei, *Klementz* 632 (ANSP, UCLA); northwestern Mongolia, *Krascheninnikov* 152 (NYBG), *Polynov & Lebedev* 405 (UC).

The flower is very similar to that of *P. comosa* to which this species is apparently related. However, it is a more delicate plant and differs from the latter in the calyx and corolla being smaller, the bracts broader and trifid, the calyx more reticulate and the lower lip of the corolla not ciliate along the margins.

117. **Pedicularis comosa** Linnaeus Plate I, fig. 94.

Pedicularis comosa L., Sp. Pl. 609, 1753; Maxim., in Bull. Acad. St. Pétersb., 24: 81, 1878; 32: 610, 1888; in Mél. Biol., 10: 122, 1878; 12: 906, 1888; Limpricht, in Repert. Sp. Nov., 20: 218, 1924. Linnaeus' type was from Europe: "Habitat in Alpibus Helveticis."

Europe to Siberia and northern Mongolia.

DZUNGARIA: *Schrenk* 1087 (ANSP).

This common species of Europe and Siberia also extends to northern Mongolia. Only a specimen from adjacent Dzungaria is at hand, while nothing has been seen from Mongolia. With this species are associated a number of others of more local distribution in northern Mongolia and Dzungaria as well as adjacent Siberia, such as *P. altaica, P. breviflora, P. dolichorrhiza, P. venusta,* etc., which can be differentiated by characters as outlined in the key.

118. **Pedicularis laeta** Steven Plate I, fig. 95.

Pedicularis laeta Stev., in Bunge ex Ledeb., Fl. Ross., 3: 289, 1847-49; Maxim., in Bull. Acad. St. Pétersb., 32: 610, fig. 150, 1888; in Mél. Biol., 12: 906, fig. 150, 1888; Limpricht, in Repert. Sp. Nov., 20: 220, 1924. The type was from Russia: "Rossia media! [in graminosis ad Wolgam circa Saratow (Bunge) inter fluvios Choper et Wolga (Stev. in litt.), ..."

From Europe to Siberia, Dzungaria, and northern Mongolia. Flowers purple. No specimen from Mongolia has been seen.

DZUNGARIA: *Schrenk* s.n. (NYBG, USNH), 1081 (ANSP).

119. **Pedicularis uliginosa** Bunge Plate I, fig. 96.

Pedicularis uliginosa Bunge, Ind. Sem. Hort. Dorpat., 8, 1839; in Bull. Acad. St. Pétersb., 8: 251, 1841; Benth., in DC., Prodr., 10: 570, 1846; Maxim., in Bull. Acad. St. Pétersb., 24: 78, 1878; 32: 610, fig. 151, 1888; in Mél. Biol., 10: 118, 1878; 12: 906, fig. 151, 1888; Limpricht, in Repert. Sp. Nov., 20: 220, 1924. The type was "(P. rubens fl. alt. non Steph. P. altaica Steph. hbr.)."

Marshy alpine meadows from Siberia to the Pamirs, Dzungaria and Mongolia. Flowers reddish purple. Flowering in August.

DZUNGARIA: *Schrenk* s.n. (ANSP, USNH).

MONGOLIA: northern Mongolia and Khangai near Mogoi-delan, *Ikonnikov-Galitzky* 697 (NYBG).

This species is closely related to *P. rubens*, differing in the broader, less pinnatifid leaf-segments, the broader and more profoundly serrate calyx-teeth, and the more distinct beak. The inflorescences of *P. rubens* are usually more densely pubescent.

120. Pedicularis rubens Stephan Plate I, fig. 97.

Pedicularis rubens Steph. ex Willd., Sp. Pl., 3: 219, 1800; Maxim., in Bull. Acad. St. Pétersb., 24: 79, 1878; 32: 610, fig. 152, 1888; in Mél. Biol., 10: 119, 1878; 12: 907, fig. 152, 1888; Komarov, in Act. Hort. Petrop., 25: 458, 1907; Limpricht, in Repert. Sp. Nov., 20: 220, 1924. The type was from Siberia: "Pedicularis rubens. Stephan in litt. . . . . Habitat in Siberia media."

Siberia to northern Mongolia. Flowers reddish purple. Flowering in July.

MONGOLIA: Fluvium Uz-terchi, *Klementz* s.n. (ANSP), ad rivulum Bain-Zagan, *Klementz* s.n. (UCLA); Montes Kentei ad fontes fluviorum Tola, Mensa et Iro, *Ikonnikov-Galitzky* 2 (NYBG); Montes Kentei orientales ad fontes fluviorum Kerulen et Onon, *Ikonnikov-Galitzky* 191 (UC); Mongolia and Khangai, *Ikonnikov-Galitzky* 426 (UC).

121. Pedicularis flava Pallas Plate I, fig. 98.

Pedicularis flava Pall., Reise, 3: 736, pl. R, fig. 1A, 1776; Maxim., in Bull. Acad. St. Pétersb., 24: 81, 1878; 32: 611, fig. 153, 1888; in Mél. Biol., 10: 122, 1878; 12: 907, fig. 153, 1888; Komarov, in Act. Hort. Petrop., 25: 457, 1907; Limpricht, in Repert. Sp. Nov., 20: 221, 1924. The type was: "In glareosis circa Onon-Borsa fl. copiose, nec alibi observata [Pallas]."

Siberia to Mongolia at an altitude of about 1580 meters, in wash of broad main valley. Flowers yellow. Flowering in June.

MONGOLIA: Vallis Judshoktui, *Klementz* s.n. (ANSP, UCLA); southwestern foothills of Khangai Mountains, vicinity of Kholt, *Iusev* 342 (NYBG); Montes Kentei ad fontes fluviorum Tola, *Ikonnikov-Galitzky* 2032 (UC); Tsaga Nor, *Chaney* 175 (GH, UC, USNH).

The plants from northern Mongolia, as compared with those from Siberia, are lower, with more radical leaves and very much thickened roots. They apparently grew in a drier habitat and may represent a different form of the species.

This species resembles *P. physocalyx* Bunge, a species of Siberia and Dzungaria, in general appearance, but can be distinguished by broader corolla, densely pubescent calyx which is not reticulate, shorter galea which is about as long as the lower-lip, and hairy anterior filaments.

122. Pedicularis mandshurica Maximowicz Plate I, fig. 99.

Pedicularis mandshurica Maxim., in Bull. Acad. St. Pétersb., 24: 79, 1878; 32: fig. 154, 1888; in Mél. Biol., 10: 120, 1878; 12: fig. 154, 1888; Komarov, in Act. Hort. Petrop., 25: 454, 1907; Limpricht, in Repert. Sp. Nov., 20: 221, 1924. The types were from Manchuria: "In Mandshuria orientali montana: in jugo graminoso inter fl. Dadso-schu et aestuarium St. Wladimiri perfrequens; declivitatibus lapidosis litoreis circa sinum St. Olgae passim (ipse, spec. fere glabrum leg. F. Schmidt), nec non in collibus sinus Possjet (F. Schmidt)." These have not been seen.

Northern Korea and eastern Manchuria. No specimens seen from the latter region.

KOREA: northern Korea, Fluvium Tumin-gan, Districtus Cheneng, Vallis Tupongan, *Komarov* 1419 (ANSP, NYBG, UCLA).

In the absence of material from Manchuria, where the types were collected, the illustration here given is based on the Korean specimen studied.

123. **Pedicularis lasiostachys** Bunge

Pedicularis lasiostachys Bunge, in Ledeb. Fl. Alt., 2: 434, 1830; Maxim., in Bull. Acad. St. Pétersb., 32: 611, fig. 156, 1888; in Mél. Biol., 12: 908, fig. 156, 1888; Limpricht, in Repert. Sp. Nov., 20: 221, 1924. The type was from the Altai region: "Hab. in udis summae alpis ad fl. Tschuja contra ostium fl. Tschegan jacentis (B[unge])."

Russia to the Caucasus, Siberia and northern Mongolia.

Recorded by Maximowicz and Limpricht from northern Mongolia. No specimen from the latter region has been seen. A specimen from the Altai region in Siberia, collected by Krylow, is in the herbarium of the Academy of Natural Sciences of Philadelphia.

124. **Pedicularis achilleifolia** Stephan

Key to the Varieties

A. Flowers larger; calyx about 8 mm. long; corolla about 18 mm. long. 124a. *P. a. typica*

AA. Flowers smaller; calyx about 6-8 mm. long; corolla about 12-15 mm. long. 124b. *P. a. parviflora*

124a. **Pedicularis achilleifolia** typica Plate I, fig. 100.

Pedicularis achilleifolia Steph. ex Willd., Sp. Pl., 3: 219, 1800; Benth., in DC. Prodr., 10: 571, 1846; Maxim., in Bull. Acad. St. Pétersb., 24: 79, 1878; 32: 611, fig. 157, 1888; in Mél. Biol., 10: 120, 1878; 12: 908, fig. 157, 1888; Limpricht, in Repert. Sp. Nov., 20: 222, 1924. The type was from Siberia: "Pedicularis achilleaefolia. Stephan in litt. . . . Habitat in Sibiria."

Siberia to northern Mongolia. Flowers pale yellowish, almost white. Flowering in June.

DZUNGARIA: *Schrenk* s.n. (ANSP, USNH); Dzungaria, ad lacum Saisang-Nor, *Fischer* s.n. (ANSP, NYBG).

MONGOLIA: Fluvium Chanyn-gol, *Klementz* s.n. (ANSP, UCLA).

124b. **Pedicularis achilleifolia parviflora** Maximowicz

Pedicularis achilleifolia var. *parviflora* Maxim., in Bull. Acad. St. Pétersb., 24: 79, 1878; 32: 612, 1888; in Mél. Biol., 10: 120, 1878; 12: 908, 1878; Limpricht, in Repert. Sp. Nov., 20: 223, 1924. The type, "Mongolia orientali australi: montibus Summa-Lada, rara in declivitatibus sterilibus valde lapidosis (Przewalski)," has not been seen.

Southeastern Mongolia. No specimen seen.

Series 34. Compactae

Compactae Maxim., in Bull. Acad. St. Pétersb., 32: 574, 1888; in Mél. Biol., 12: 854, 1888.

Tall, erect plants; stem simple, foliate; leaves radical and cauline, petiolate, pectinately pinnatifid to more often pinnatisect, the lobes ovate-lanceolate, inciso-serrate; inflorescences many-flowered, more or less compact, sometimes interrupted near the base; pedicels very short; bracts foliaceous, much shorter than the flowers; calyx more or less cleft anteriorly, broadly ovoid, not reticulate, 5-dentate, the teeth deltoid, entire; corolla yellow, the tube slightly longer than the calyx, sometimes bending, the galea glabrous, the beak conical, distinct, the lower lip 3-lobed, the lobes subequal, rounded, ciliate or glabrous on the margins; filaments inserted near the middle of the corolla-tube, 2 of them hairy distally or all glabrous.

About 13 species widely distributed from Europe to Siberia and North America. Only 1 species extends to northern Mongolia (Map 16).

125. **Pedicularis compacta** Stephan Plate 2, fig. 101.

Pedicularis compacta Steph. ex Willd., Sp. Pl., 3: 219, 1800; Maxim., in Bull. Acad. St. Pétersb., 24: 166, 1878; 32: 576, fig. 81, 1888; in Mél. Biol., 10: 101, 1878; 12: 856, fig. 81, 1888; Limpricht, in Repert. Sp. Nov., 20: 231, 1924. The type was from Siberia: "Pedicularis compacta. *Stephan in Litt.* . . . *Habitat in* Siberiae *pratis.*"

Siberia to northern Mongolia. No specimen seen from the latter region. Flowers yellow.

DZUNGARIA: *Schrenk* s.n. (USNH), 1077 (ANSP).

Recorded by Maximowicz and Limpricht as occurring in northern Mongolia. In the absence of material from the latter region, the plant is here illustrated from specimens from Dzungaria. The species is closely related to those of the series Comosae but is characterized by a bending corolla without teeth on the galea and with a longer beak.

SECTION XI. CLADOMANIA

Tall plants; stems single or several together, glabrous or rarely puberulous, many-branched above; leaves cauline, alternate, oblong-lanceolate, pinnatifid to pinnatisect; flowers shortly and loosely racemose, short-pedicellate; calyx mostly 2-parted above, the teeth entire to dentate; corolla yellow to purple: tube erect, slightly exceeding the calyx in length; galea erect, very shortly rostrate at apex with a subulate tooth on each side of the lower margin; lower lip about as long as the galea or very slightly longer, 3-lobed, the lobes rounded, the middle one slightly distad; styles mostly included; staminal filaments glabrous or hairy.

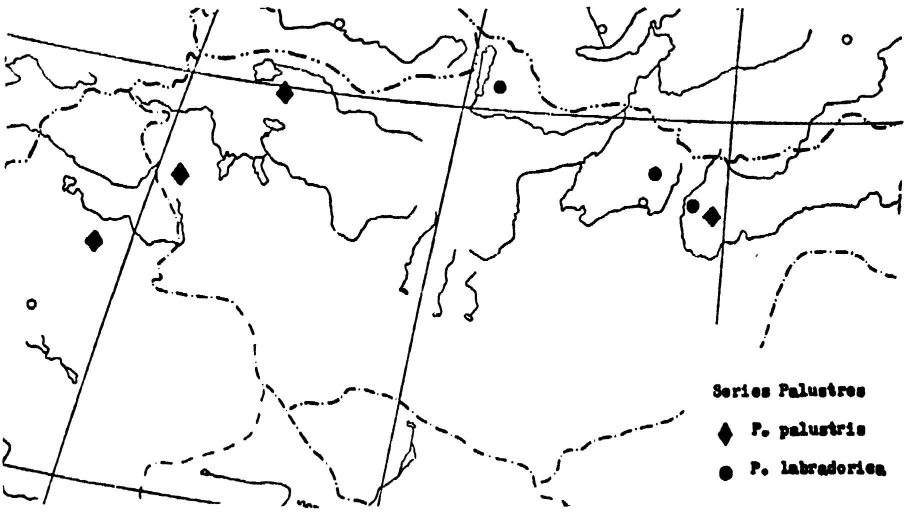
This section is closely related to the section Apocladus which has a similar type of corolla. It differs from the latter in the branching habit, in the fewer and more loosely arranged flowers, in the 2-dentate calyx, etc. The range of the section is in the subarctic to cold temperate regions of both hemispheres.

Series 35. Palustres

Palustres Maxim., in Bull. Acad. St. Pétersb., 24: 73, 1878; in Mél. Biol., 10: 111, 1878.

Plants tall; stems single or several together, glabrous or rarely puberulous, many-branched above; leaves cauline, alternate, oblong-lanceolate, pinnatifid to pinnatisect; flowers shortly and loosely racemose, short-pedicellate; calyx mostly 2-parted above, the teeth entire to dentate; corolla yellow to purple; tube erect, slightly exceeding the calyx; galea erect, very shortly rostrate at apex and with a subulate tooth on each side of the lower margin, sometimes also with a tooth-like protuberance near the middle of the lower margin; lower lip about as long as the galea or very slightly longer, 3-lobed, the lobes rounded, the middle one slightly distad; styles mostly included; staminal filaments glabrous or hairy.

About 9 species in Arctic and subarctic regions of both hemispheres. Two species extend to northern Mongolia and Sinkiang (Map 17).



Map 17.—Distribution of the series Palustres.

Key to the Chinese Species

A. Leaves deeply pinnatifid to near the midrib; calyx-teeth dentate; galea with 2 teeth-like protuberances near the middle of the lower margins. .. 126. *P. palustris*

AA. Leaves mostly serrate to shallowly pinnatifid, rarely deeply pinnatifid; calyx-teeth entire or nearly so; galea without 2 teeth-like protuberances near the middle of the lower margins. .... 127. *P. labradorica*

126. Pedicularis palustris Linnaeus Plate 2, fig. 102.

Pedicularis palustris L., Sp. Pl., 1: 607, 1759; Benth., in DC. Prodr., 10: 566, 1846; Maxim., in Bull. Acad. St. Pétersb., 24: 75, 1878; 32: 607, 1888; in Mél. Biol., 10: 113, 1878; 12: 901, 1888; Komarov, in Act. Hort. Petrop., 25: 458, 1907; Limpricht, in Repert. Sp. Nov., 20: 215, 1924. Linnaeus' type was: "Habitat in Europae septentrionalis paludibus."

In marshy places from Europe to Siberia, northern Mongolia, and Sinkiang. Flowers purple. Flowering in July.

MONGOLIA: Montes Kentei orientales ad fontes fluviorum Kerulen et Onon, *Ikonnikov-Galitzky* 1533 (NYBG).

DZUNGARIA: *Schrenk* s.n. (USNH).

127. Pedicularis labradorica Wirsing Plate 2, fig. 103.

Pedicularis labradorica Wirsing, Eclog. Bot., pl. 10, 1778; Fernald, in Rhodora, 33: 193, 1931; Merrill, in op. cit., 40: 292, 1938. The type, "a Labradorica accepimus," was from North America. This name was given by Willdenow under *P. euphrasioides*, but as a variety "*β. P. (labradorica).*" Later authors treated the Eurasian and North American plants as conspecific, and the two names as synonymous. After examining many specimens from both regions, I am convinced that this is the best

'Houttuyn Lin. Pfl. Syst. 8. p. 39. t. 57c." Merrill pointed mistake in crediting the authorship to Houttuyn and traced the authorship back to Wirsing.

Pedicularis euphrasioides Steph. ex Willd., Sp. Pl., 3: 204, 1800; Maxim., in Bull. Acad. St. Pétersb., 24: 74, 1878; 32: 606, fig. 136, 1888; in Mél. Biol., 10: 112, 1878; 12: 901, fig. 136, 1888; Komarov, in Act. Hort. Petrop., 25: 456, 1907; Limpricht, in Repert. Sp. Nov., 20: 214, 1924. Stephan's type was from Siberia: "P. euphrasioides. . . . Stephan in litt. . . . Habit in Sibiria ad Lenam fluvium."

In arctic and subarctic Eurasia and North America. In northern Mongolia near the edge of deciduous forests. Flowers yellowish with purplish tinge. Flowering in July.

MONGOLIA: Lake Kossogol, *Komarov* s.n. (ANSP, UCLA); Montes Kentei orientales ad fontes fluviorum Kerulen et Onon, *Ikonnikov-Galitzky* 104 (UC), 227 (NYBG); vicinity of Ular-Batur-Khoto, *Ikonnikov-Galitzky* 295 (NYBG, UC); Montes Kentei ad fontes fluviorum Tola, Mensa et Iro, *Ikonnikov-Galitzky* 2768 (UC).

The species is a variable one. There is considerable variation in the size of the plant, branching of the stems, shape and size of the leaves, and color of the corolla. However, the fundamental characters of the plants from different localities agree very well with each other, and it is desirable to consider them as all of a single species. As Maximowicz pointed out, the plants from the southern part of the Asiatic range of the species have more purplish, sometimes nearly purely purple corolla. But purplish-tinged corollas on plants from other regions are not uncommon, sometimes appearing on plants growing together with purely yellow-flowered ones. Hultén recognized a var. *simplex* from Kamchatka (in Kungl. Svenska Vetens. Hand. III, 8 (2): 115, 1930 (Fl. Kamtch.)), which has unbranched stem and thinner and more dissected leaves; this I think is hardly recognizable even as a form, and it is found in other localities as well.

SECTION XII. PHYLLOMANIA

Stems usually erect, often branching; leaves mostly cauline, numerous, small, rarely large, pinnatifid to pinnatisect, short- to long-petiolate; flowers in terminal compact, long or short inflorescences; calyx campanulate to cylindric, usually cleft anteriorly, 5-dentate, the teeth equal to unequal, broad and incised-serrate, sometimes the posterior entire; corolla with the tube as long as or slightly longer than the calyx; galea with or without a beak, which may be conical to filiform; lower lip with subequal or unequal lobes, the middle lobe usually small, distad or not.

This section is characterized by the numerous cauline leaves which are usually small and short-petiolate, rarely large and long-petiolate, and by the relatively short inflorescences. The relationship with the section Haplophyllum through the Carnosae is apparent and they are probably derived from a common stock with one group specializing in more simple leaves forming the section Haplophyllum and another in more dissected leaves forming the Multifoliae. This section is distributed from the eastern Himalayas to Yunnan, Kweichow, and Sikang, with one species, *P. henryi*, widely scattered in central and southern China.

Series 36. Microphyllae

Microphyllae Prain, in Ann. Bot. Gard. Calcutta, 3: 76, 1890.

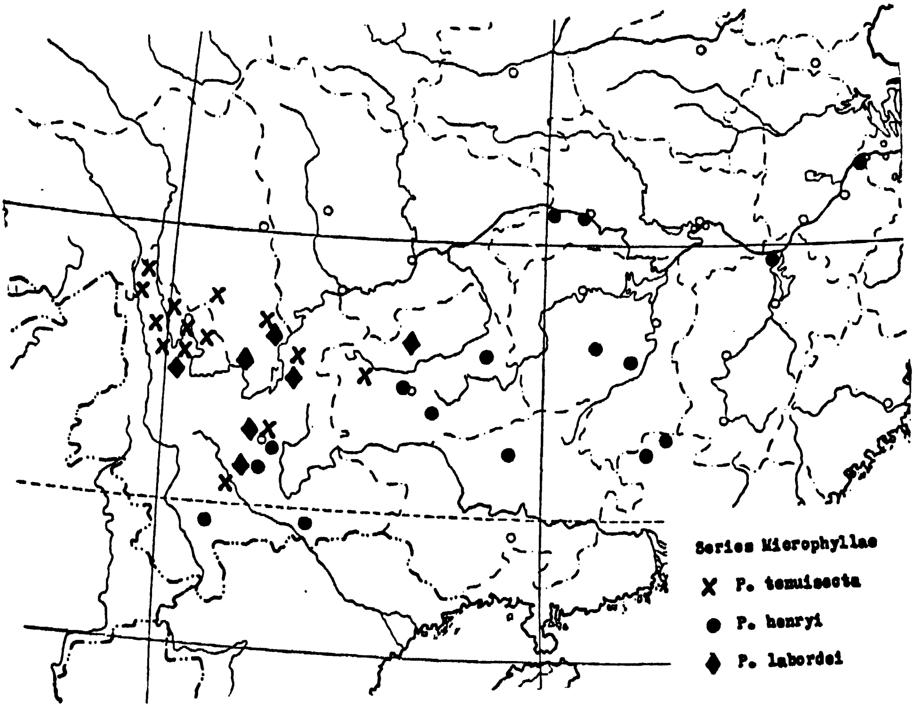
Erect branching plants, sometimes the branches diffused at base; stems rigid, pubescent, many-leaved; leaves usually medium-sized or small, alternate, sessile to petiolate, the lamina usually oblong, pinnatisect to deeply pinnatifid, the segments deeply pinnatifid to serrate, cartilaginous-serrulate on the margins; inflorescences terminal, compact; bracts foliaceous; pedicels short; calyx campanulate to cylindric, cleft anteriorly, 5-dentate, the teeth equal, broad to flabellate-rounded, incised-serrate; corolla rose to purple, the tube longer than the calyx, straight or slightly bending, slightly enlarged distally; galea curved at the middle or distally, with or without a beak, the beak conical to short-filiform; lower lip 3-lobed, the lobes rounded, the middle smaller; filaments inserted at the lower part of the tube, all hairy; stigmas slightly exserted; capsules ovate, slightly exserted.

About 4 species from the eastern Himalayas to southwestern and southern China (Map 18).

This series is closely related to the series Carnosae. The leaves of the species of the Carnosae are crenate, while those of the Microphyllae are usually smaller, deeply pinnatifid to pinnatisect. The calyx of the Carnosae has 2 teeth only, while in the Microphyllae there are 5 teeth. In the Carnosae the staminal filaments are glabrous or very sparsely hairy while in the Microphyllae they are all more or less densely hairy.

Key to the Chinese Species

A. Leaves twice pinnatisect or once pinnatisect and with deeply pinnatifid linear segments; galea elongated, curved at the middle, ending in an obtuse or truncate apex without a beak. .... 128. *P. tenuisecta*



Map 18.—Distribution of the series Microphyllae.

AA. Leaves once pinnatisect or deeply pinnatifid, the segments broad, ovate or oblong, crenate; galea curved distally, ending in a conical or short-filiform beak.

B. Calyx-teeth short, without stipitate bases; corolla to 2.5 cm. long; beak short, conical; lower lip of corolla glabrous on the margins. .... 129. *P. henryi*

BB. Calyx-teeth long, with long-stipitate bases; corolla 2.6-3 cm. long; beak long, filiform; lower lip slightly ciliate on the margins. .... 130. *P. labordei*

128. Pedicularis tenuisecta Franchet Plate 2, fig. 104.

Pedicularis tenuisecta Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 558, fig. 46, 1888; in Mél. Biol., 12: 831, fig. 46, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 217, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 85, 1911; 7: 422, 1922; 8: 41, 1913; 15: 162, 1926; in Bull. Soc. Bot. Genève II, 5: 112, 1913; Limpricht, in Repert. Sp. Nov., 20: 240, 1924; 23: 337, 1927; Hand.-Maz., Symb. Sin., 7: 859, 1926. Franchet's type was from: "Yunnan, Monte Pée-ngay-tze supra Tapin-tze in sylvis (Delavay! in Mus. Paris.)." This is evidently *Delavay* 329, two isotypes of which pass from the Bonati Herbarium to the University of California at Los Angeles and the Academy of Natural Sciences of Philadelphia, while another is at the New York Botanical Garden.

Alpine meadows or in coniferous forests at altitudes of 1500 to 3660 meters in Yunnan, southern Sikang, and western Kweichow. Flowers purplish red. Flowering from August to November.

SIKANG: Muli, *Ward* 4785 (RBGE); Si-chang District, *Yü* 1283 (GH); Huei-li District, *Yü* 1435 (GH), 1542 (GH).

YUNNAN: no precise locality, *Delavay* s.n. (ANSP, UCLA, USNH); Ta-pin-tze, *Delavay* 329 (ANSP, NYBG, UCLA); no precise locality, *Monbeig* s.n. (UCLA); Tsekou, *Monbeig* s.n. (NYBG, USNH), 39 (UCLA), 45 (ANSP); Yunpe, *Ten* 9 (RBGE); Yunnan sen, *Ducloux* s.n. (UCLA); Yunnan sen, Tchong Chan, *Ducloux* 696 (ANSP, NTU, UCLA, USNH); Tsekou, *Soulié* 1669 (UCLA); Yuanchiang, *Henry* 13230 (MBG, NYBG, USNH); Likiang, *Schneider* 3364 (USNH); eastern flank of the Tali Range, *Forrest* (ANSP), 4495 (UCLA); Lotzo Lo, between Likiang, Youngning and Youngpei, en route to Mili, *Rock* 5323 (NYBG, USNH); eastern slopes of Likiang Snow Range, *Forrest* 2785 (NTU, UCLA), 6294 (ANSP), *Rock* 5662 (USNH), 5846 (ANSP, GH, NYBG, UC, USNH); Wei-si District, *Tsai* 59560 (AA); Champutung, Soo-roo-la, *C. W. Wang* 66667 (AA); Atungtze, *C. W. Wang* 69379 (AA), *Yü* 7943 (AA); Muli, Wachin, Yunnanpuh, *Yü* 14505 (AA); Likiang Snow Range, *Yü* 15588 (AA), *Ching* 21120 (AA), 30563 (AA); southern Chungtien, *Feng* 2043 (AA), 3376 (AA); no precise localities, *Forrest* 28915 (ANSP), *Tsai* 57648 (AA), *Yü* 7585 (AA), 13466 (AA).

KWEICHOW: Shiucheng, *Tsiang* 9428 (NYBG).

A distinct species readily recognized by its twice pinnatisect leaves with linear segments. Bonati recognized a white-flowered form as follows:

128a. **Pedicularis tenuisecta** f. **albiflora** Bonati

Pedicularis tenuisecta f. *albiflora* Bonati, in Notes Bot. Gard. Edinb., 8: 40, 1913; Limpricht, in Repert. Sp. Nov., 20: 240, 1924. The type was from northwestern Yunnan: "'Plant of 15 inches. Flowers white. Open pasture on the margins of pine forests on the eastern flank of the Likiang Range. Lat. 27° 25′ N. Alt. 11,000 ft. August 1910.' G. Forrest. No. 6330." It has not been seen.

No specimen seen. Limpricht also referred *Monbeig* 39 and 45 to this white-flowered form but these two numbers in the Bonati Herbarium clearly show that their flowers were purplish red, the violet tinge being still evident in the long-preserved specimens.

129. **Pedicularis henryi** Maximowicz Plate 2, fig. 105.

Pedicularis henryi Maxim., in Bull. Acad. St. Pétersb., 32: 560, fig. 54, 1888; in Mél. Biol., 12: 833, fig. 54, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 209, 1890; Diels, in Bot. Jahrb., 29: 572, 1900; Bonati, in Bull. Soc. Bot. France, 54: 186, 1907; Limpricht, in Repert. Sp. Nov., 20: 240, 1924; 23: 337, 1927; Merrill, in Sunyatsenia, 1: 206, 1934; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 212, 1934. Maximowicz's type was from: "Hupeh: Nant'o et montes boream versus (Dr. Henry! 1887)." This evidently includes several collections, as Forbes and Hemsley cited: "Hupeh: Changlo, South Patung, Nanto and mountains to the northward (*A. Henry!*). Herb. Kew." It is highly probable that the three Henry specimens available, *Henry* 4687, 6155, 6304, from the Bonati Herbarium (passing to University of California at Los Angeles), the Gray Herbarium, and the United States National Herbarium respectively, all collected by him in Hupeh from 1885 to 1889 but without field data, are among the type collections cited by Maximowicz.

Pedicularis bodinieri Vaniot ex Bonati, in Bull. Intern. Acad. Géogr. Bot., 13: 243, 1904; Limpricht, in Repert. Sp. Nov., 20: 240, 1924. The types were from Kweichow: "Kouy-Tchéou, environs de Kouy-Yang, montagne du Collège, pentes herbeuses, 26 mai 1898 Leg. E. Bodinier no. 2285. Cimetière des Chrétiens, a Ta-yn-po, Leg. Bodinier, 31 Mai 1897, no. 601." These have not been seen. Also cited was *Cavalerie* 808: "La même plante, plus diffuse et plus velue a été recoltée dans la même région par la R. P. Cavalerie à Pin-Fa (12 mai 1902), no. 808." This is in the Bonati Herbarium. Bonati (in Notes Bot. Gard. Edinb., 15: 161, 1926) mentioned the identity of this species with *P. henryi*, and Limpricht made the reduction in his supplementary list of *Pedicularis* (in Repert. Sp. Nov., 23: 337, 1927).

Open mountain slopes at altitudes of 400 to 1420 meters in Yunnan, Kweichow, Hupeh, Hunan, Kiangsi, Kiangsu, Kwangsi, and Kwangtung. Flowers purplish red. Flowering from May to August.

Kiangsu: Nanking, *Macklin* 41a (ANSP, CM).

Hupeh: no precise locality, *Henry* 6155 (GH, NYBG), 6304 (USNH); Ichang, *Henry* 4687 (ANSP), *Wilson* 494 (ANSP, NYBG, UCLA, USNH); Patung District, *Chow* 498 (NYBG).

Yunnan: no precise locality, *Maire* 2612 (UC), *Ward* s.n. (RBGE); Leang-ouang-chan, *Delavay* 6905 (ANSP, NYBG, UCLA); Szemao, *Henry* 10731 (NYBG); Yunnan sen, Tchong chan, *Ducloux* 699 (ANSP, NTU, UCLA), 786 (ANSP, NTU, UCLA); Shweli-Salween divide, *Forrest* 11917 (UCLA); Ping-pien District, *Tsai* 60439 (AA), 62196 (AA), 62253 (AA), 62430 (AA); Cheng-kiang, *H. Wang* 41603 (AA).

Kweichow: no precise locality, *Cavalerie* s.n. (UCLA), 3232 (UCLA, USNH); Pin-fa, *Cavalerie* s.n. (NTU), 808 (ANSP, UCLA); Kin-tchen-hia, *Cavalerie* 2777 (UCLA); Kouy hoa, Ouang mou, *Esquirol* 40 (ANSP, NTU, UCLA); Kiang-kow, Fan Ching Shan, *Tsiang* 7552 (NYBG).

Kwangsi: Luchen, Tung Loo, *Ching* 5640 (NYBG).

Hunnan: Hsinhwa, Hsikwangschan, *Handel-Mazzetti* 11903 (USNH); Heng Shan, *Wang-Te-Hui* (USNH).

Kiangsi: Lushan, *Steward* 2493 (GH, MBG, UC, USNH), *Tsiang* 10750 (NYBG), *Chung & Sun* 519 (NYBG).

Kwangtung: Lohchang, *Tso* 20458 (NYBG), *N. K. Chun* 42975 (NYBG), *C. Wang* 31331 (NYBG); Yu-yuen, *Ko* 9118 (NYBG).

This is one of the most widespread species in southern China. It is found in Yunnan and Kweichow in the west, in western Hupeh and northern Kiangsi along the Yangtze River in the north, and in northwestern Kwangsi and northern Kwangtung in the south. It is the only species of *Pedicularis* found in Kwangtung, occurring in Loh-chang and Yu-yuen in the northern part of the province near the Hunan border.

This species is most closely related to *P. labordei* but can be distinguished by its larger leaves, smaller flowers, broader and shorter calyx-teeth, and broader, shorter galea-beak.

130. Pedicularis labordei Vaniot Plate 2, fig. 106.

Pedicularis labordei Vaniot ex Bonati, in Bull. Acad. Géogr. Bot., 13: 242, 1904; Limpricht, in Repert. Sp. Nov., 20: 240, 1924. The type, "Kouy-Tchéou. Mont. de Kao-Po (Tsin Gay). Bords des ruisseaux, endroits marécageux. Leg. J. Laborde, 10 sept. 1899, herbier Bodinier no. 2724," has not been seen. According to the original description, only the anterior filaments are hairy. In all specimens examined, however, including some of those later named by Bonati, the four filaments are all hairy, the posterior ones being more sparsely so.

Pedicularis stapfii Bonati, in Arch. Bot. Caen Bull., 1: 3, 1927; Limpricht, in Repert. Sp. Nov., 23: 337, 1927. The type was from northeastern Yunnan: "Yunnan, Tong-Tchouan: Dans les flaques d'eau derrière la ville, alt. 2.700 m.; fleurs complétement roses (E. E. Maire)." This unnumbered specimen of Maire, according to Bonati, was collected in 1908. It was not found in the Bonati Herbarium, unless it be *Maire* 3276, of which quite a number of specimens are in the Bonati Herbarium but without Maire's habitual original field notes. Only Bonati's labels are found in this case, two specimens being named by him as *P. labordei* while the others are left unnamed. Maire's collections were originally unnumbered, the numbers being normally added in Bonati's handwriting. These specimens agree well both with the original descriptions of *P. labordei* and of *P. stapfii*, these descriptions proving the two synonymous.

Alpine meadows at altitudes of 2800 to 3500 meters in northern Yunnan, southeastern Sikang and northwestern Kweichow. Flowers rose to purplish red. Flowering from July to September.

SIKANG: Muli, *Ward* 4782 (RBGE); Si-chang District, *Yü* 1311 (GH); Yien-pien District, *Yü* 1734 (GH).

YUNNAN: no precise locality, *Maire* 6377 (ANSP, NTU, UCLA); Tang-yang-tschang, Mo so yn, *Delavay* s.n. (UCLA); Yo-li-chan, *Delavay* 6718 p.p. (USNH); Yunnan sen, *Ducloux* 915 (ANSP, UCLA); San-chan, near Tchen-kiong, *Ducloux* 3979 (UCLA); Tong-tchouan, *Maire* 3276 (ANSP, NTU, UCLA), 3949 (ANSP, NTU, UCLA), 6382 (ANSP, NTU, UCLA); Ho-kia-keou, *Maire* 3924 (ANSP, NTU, UCLA); Ie-ma-tch'ouan, *Maire* 6369 (ANSP, NTU, UCLA); Likiang, *Schneider* 3079 (GH, USNH), *Rock* 13625 p.p. (USNH); Yunpe, *Ten* 88 (RBGE).

KWEICHOW: Hua-mei-tsing, Ta-tung, *Tsiang* 8834 (NYBG, UC).

In the the floral characters this species differs from *P. tenuisecta* and *P. henryi*, to both of which it is related, in the rather long beak and in the filiform stipitate and elongated calyx-teeth. From *P. henryi*, to which it is particularly close in vegetative characters, it also differs in the larger size of the flowers and the slightly ciliate-margined lower lip.

Series 37. Furfuraceae

Furfuraceae Prain, in Ann. Bot. Gard. Calcutta, 3: 75, 1890.

Erect, the stem simple or branching near the base; leaves large, mostly cauline, long-petiolate, ovate to lanceolate, pinnatifid to pinnatisect, the segments subentire to serrate; flowers more or less compactly arranged, short-pedicillate; bracts petiolate, foliaceous; calyx membranaceous, ovoid to campanulate, not, or only slightly cleft anteriorly, 5-dentate, the teeth unequal to subequal, all serrate or the posterior one entire; corolla-tube as long as or slightly longer than the calyx, glabrous, erect; galea bending near the middle, ending in a distinct filiform beak, acute or 2-fid at the tip; lower lip 3-lobed, the lobes subequal to unequal, the median lobe more or less distad, ciliate or glabrous on the margins; staminal filaments inserted near the middle or the top of the tube, 2 or all 4 hairy distally; stigmas slightly exserted or included; capsules lanceolate, long exserted.

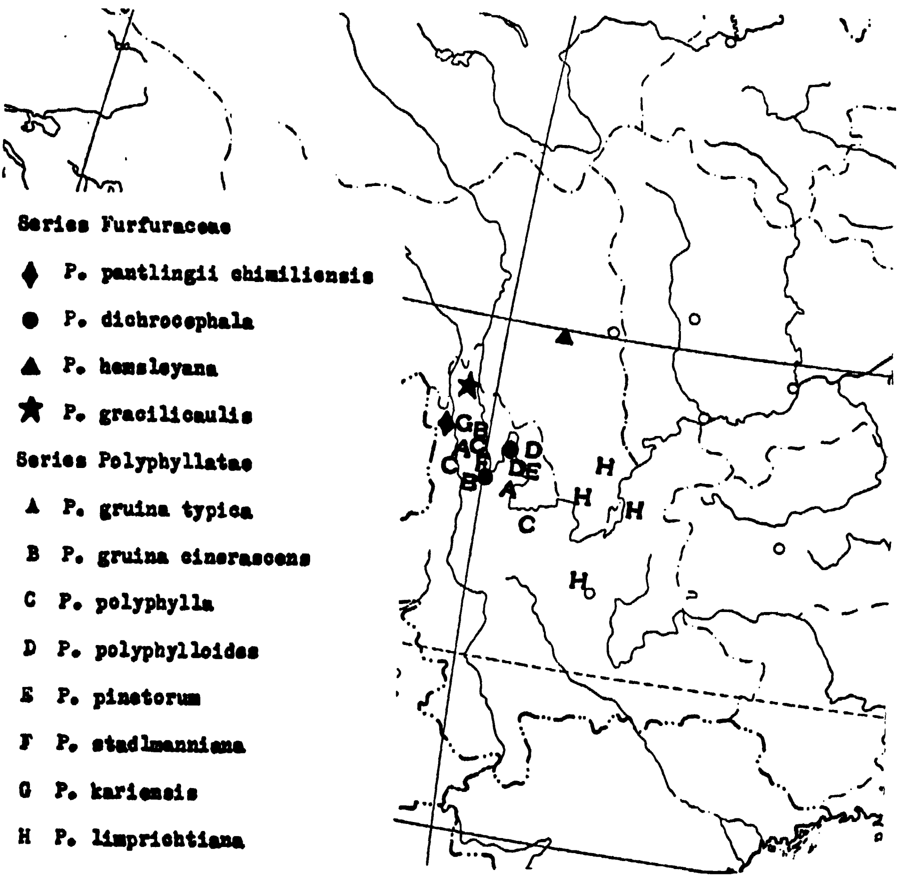
About 5 or 6 species from the eastern Himalayas to Sikang and northwestern Yunnan (Map 19).

This series is related to the Carnosae and Microphyllae, from both of which it can mainly be distinguished by the long-petiolate leaves and the presence of 5 unequal or subequal calyx-teeth, the shorter corolla-tube which equals or slightly exceeds the calyx in length, the distinct filiform beak of the galea, and the relatively large, more or less projected middle lobe of the lower corolla-lip. From the Carnosae it can also be distinguished by the pinnatisect to pinnatifid leaves; and from the Microphyllae by the entire or shallowly cleft calyx and the narrower calyx-teeth.

Key to the Chinese Species

A. Leaves shallowly to deeply pinnatifid; lower corolla-lip usually ciliate on the margins.

  B. Leaves all cauline, the blades shallowly pinnatifid; calyx not cleft; beak straight; lower lip with the middle lobe slightly smaller than the lateral; anterior staminal filaments hairy. . . . . 131. *P. pantlingii*



Map 19.—Distribution of the series Furfuraceae and Polyphyllatae.

BB. Leaves basal and cauline, the blades deeply pinnatifid; calyx not cleft anteriorly; beak bending distally; lower lip with the middle lobe as large as the lateral; all 4 staminal filaments hairy. .... 132. *P. dichrocephala*

AA. Leaves pinnatisect, the upper ones sometimes deeply pinnatifid; lower corolla-lip glabrous on the margins.

B. Leaves larger, the blades to 6-8 cm. long; calyx not cleft anteriorly, the teeth oblong, slightly dentate; galea 2-auriculate on the margins, not cristate in front; lobes of the lower lip unequal, the middle one larger and more distad; beak acute and entire at the tip. .... 133. *P. hemsleyana*

BB. Leaves smaller, the blades to 3-3.5 cm. long; calyx cleft anteriorly, the teeth flabellate, deeply dentate; galea not auriculate on the margins, cristate in front; lobes of the lower lip subequal, the middle lobe slightly smaller and slightly distad; beak bifid at the tip. .... 134. *P. gracilicaulis*

131. Pedicularis pantlingii Prain

This is an eastern Himalayan species of which Bonati described a variety, var. *chimiliensis*, from Upper Burma. This variety was also recorded by Handel-Mazzetti as occurring in Yunnan. The differences, based on Bonati's descriptions, are as follows:

Key to the Varieties

A. Plant larger, about 4-6 dm. tall, with larger leaves (to 5 × 4.5 cm.) and larger flowers (17 mm. long); calyx-teeth unequal, the posterior one entire; lower corolla-lip hairy on the margins, the median lobe rounded. .... 131a. *P. p. typica*

AA. Plant smaller, about 3-3.5 dm. tall, with smaller leaves (3 × 3 cm.) and smaller flowers (12 mm. long); calyx-teeth subequal, all incised; lower-lip glabrous on the margins, the median lobe triangular and acute. .... 131b. *P. p. chimiliensis*

131a. **Pedicularis pantlingii** typica

Pedicularis pantlingii Prain, in Journ. As. Soc. Beng., 58(2): 273, 1889; in Ann. Bot. Gard. Calcutta, 3: 148, pl. 16, fig. B, 1890. The types were from "Eastern Himalaya: Sikkim, (Hooker, Pantling!); Chumbi, (Dr. King's collectors!)."

This species is found in the eastern Himalayas from Nepal to Upper Burma. It has not been recorded from China.

131b. **Pedicularis pantlingii chimiliensis** Bonati

Pedicularis pantlingii Prain var. *chimiliensis* Bonati, in Notes Bot. Gard. Edinb., 13: 125, 1921; Hand.-Maz., Symb. Sin., 7: 860, 1936. The type, "'Upper Burma:—Chimili Woods, Alt. 10,000 ft., in open places of the alpine woodland, July 1919' R. Farrer. No. 1143," in the Edinburgh Herbarium, has not been seen.

YUNNAN: Champutung, *Handel-Mazzetti* 9148 (RBGE).

Upper Burma and northwestern Yunnan.

132. **Pedicularis dichrocephala** Handel-Mazzetti Plate 2, fig. 107.

Pedicularis dichrocephala Hand.-Maz., Symb. Sin., 7: 863, pl. 15, no. 9, 1936. The type, "NW-Y[unnan]: Gebüsche der ktp. St. [kalttemperierte subalpine) Stüfe], 3800-4100 m. Pass zwischen Bödö und Alo se von Dschungdien, 7. VIII. 1914 (4521) und in einem Längstal an der Westseite des Gebirges Piepun dort," has not been seen.

Alpine meadows, at altitudes of about 3350 to 3450 meters, in northwestern Yunnan. Flowers rose, whitish proximally. Flowering in August.

YUNNAN: Haba Shan, north of the Yangtze loop, third peak of Likiang Snow Range, Bardar, *Rock* 24764 (CM, MBG, NYBG, UC, UP, USNH); Lao-chun Shan, southwest of Shiku and the Yangtze, *Rock* 25077 (CM, MBG, NYBG, UC, UP, USNH).

Handel-Mazzetti originally placed this species in the Oxysporae, but clearly, as the more or less compact capitate inflorescences and the 5-dentate calyx indicate, it is not of that series. Its general habit resembles very closely *P. furfuracea* Wall., and Handel-Mazzetti has stated that its proper place is undoubtedly in the Furfuraceae. He also mentioned its resemblance to *P. verbenaefolia*, an opposite-leaved species, because of its occasionally opposite leaves. However, opposite, or in reality subopposite, leaves are rather rare in *P. dichrocephala*.

133. **Pedicularis hemsleyana** Prain Text-figure 4.

Pedicularis hemsleyana Prain, in Hook. f., Ic. Pl. 23: pl. 2210, 1892; Limpricht, in Repert. Sp. Nov., 20: 241, 1924. A duplicate of the type, "Hab. China; prov.

Szechuan; *Pratt* (No. 684)," in the Edinburgh Herbarium, has been seen. This was collected near Ta-tsien-lu, now Kanting of Sikang Province.

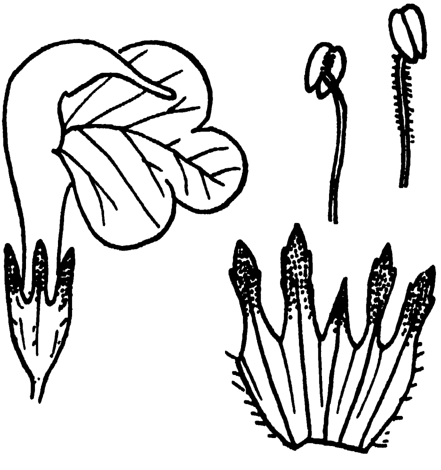
At altitudes of 2900 to 4000 meters, in Sikang Province. Flowers purple.

SIKANG: near Tachienlu, *Pratt* 684 (RBGE).

This species is characterized by long-petiolate pinnatisect leaves with oblong segments, membranaceous non-cleft calyx with 5 calyx-teeth, the posterior one being acute and entire with the others obtuse and entire or 2-serrate on each side, erect corolla with prominently projected middle lobe of the lower lip and a galea strongly bending at the middle and somewhat 2-auriculate on the ventral margins, distinct and acute beak, and 2 of the filaments hairy distally.

134. **Pedicularis gracilicaulis** sp. nov. Plate 2, fig. 108.

Planta elata, 2-4 dm. alta; caulibus singulis, gracilibus, erectis, parce puberulis vel glabrescentibus, longe ramosis, ramis gracilibus simplicibus, erectis vel interdum ad apicem paulo reflexis; foliis caulinis, longe petiolatis, alternis rarius inferioribus suboppositis, petiolis gracilibus, ad 3.5 cm. longis, laminis oblongis, ad 3 cm. longis et 1 cm. latis, pinnatisectis, membranaceis, utrinque parcissime villosis, segmentis utrinsecus 5 vel 6, ovatis vel ovato-oblongis, rotundatis, pinnatifidis et dentatis; inflorescentiis caulinis vel ramosis terminalibus, breviter racemosis, plus minusve compactis floribus inferioribus 1 vel 2 axillaribus laxis exceptis; bracteis foliaceis, 1-2 cm. longis, pinnatisectis vel pinnatilobis, petiolatis; pedicellis ad 4 mm. longis; calyce oblongo-ovoideo, membranaceo, valde villoso, 5-6 mm. longo, 5-nervo reticulato, antice ad medium fisso, margine 5-dentato, dentibus subaequalibus, inferne constrictis, superne flabellatis, profunde dentatis; corollā circiter 1.7 cm. longā, purpureā: tubo erecto, cylindrico, calycem superante, in fructibus elongato; galeā falcatā, parte inferiore circiter 3 mm. longā, parte superiore paulo curvatā, fronte cristatā, apice in rostrum abrupte productā;



Text-figure 4.—*Pedicularis hemsleyana* Prain.

rostro gracili 5 mm. longo, paulo curvato, obliquo ad apicem sub-bifido; labio inferiore superius subaequante, margine glabro, 3-lobato, lobis rotundatis, lobo medio parvo, subporrecto; staminibus ad medium tubi insertis, filamentis inferioribus glabris, superioribus ad apicem villosis, antheris oblongis; stylo incluso; capsulis ovoideis, valde compressis, oblique acutis, circiter 1.2 cm. longis 6 mm. latis, calyce exsertis.

Type, alpine meadows, along stream, at an altitude of about 3000 meters, Atuntze, northwestern Yunnan, collected in flower, July-Aug. 1935, by C. W. Wang, No. 64788; holotype in the herbarium of the Arnold Arboretum.

Alpine meadows at altitudes of 3000 to 3300 meters, in northwestern Yunnan. Flowers purple. Flowering in July and August.

YUNNAN: Atuntze, *C. W. Wang* 64788 (AA); upper Kiukiang Valley (Clulung), Chüherton, *Yü* 19701 (AA).

This species is probably related to other species of the Furfuraceae. It has long slender stems with slender branches. In the pinnatisect leaves it is similar to *P. hemsleyana* but the leaves are much smaller. It further differs from the latter in the calyx being cleft anteriorly, the teeth broader and more profoundly dentate, the galea being cristate in front and not auriculate on the ventral margins, and the beak being more slender and slightly bifid at the tip.

Series 38. Polyphyllatae

Polyphyllatae Bonati, in Notes Bot. Gard. Edinb., 13: 121, 1921.

Low or tall plants, glabrate to densely pubescent; stems often branching, erect or somewhat prostrate, the branches erect or procumbent; leaves usually small and many, cauline, alternate, short-petiolate, ovate to oblong, pinnatisect to pinnatifid, the lobes broad, serrate or carnose-serrate; inflorescences short-racemose, the flowers long- or short-pedicillate; bracts foliaceous; calyx campanulate to cylindric, cleft anteriorly, membranaceous, 5-dentate, the teeth unequal to subequal, usually broad, flabellate and dentate, sometimes the anterior ones acute and entire; corolla rose to purple, the tube erect, slightly longer than the calyx, enlarged distally, the galea sometimes hairy dorsally, prolonged into a slender, filiform beak, the lower lip about as long as the galea, the margins glabrous to ciliate, the middle lobe much smaller and hardly distad; stamens inserted at the base of the tube, the filaments all hairy or the anterior ones hairy distally; styles slightly exserted.

About five species in northwestern Yunnan and southern Sikang (Map 19).

This series was first named Polyphyllae by Maximowicz (in Bull. Acad. St. Pétersb., 32: 537, 1888; in Mél. Biol., 12: 800, 1888), and included species now divided into the Oxycarpae, Oliganthae, etc. Bonati's Polyphyllatae, of which he gave only a key to the species, is limited to *P. gruina*, *P. kariensis*, *P. stadlmanniana*, *P. polyphylloides*, and *P. polyphylla*. Of these *P. polyphylla* is now reduced to a variety of *P. gruina*. Handel-Mazzetti added two species to the series.

This series is near the Microphyllae as evidenced by the close resemblance in habit between *P. gruina* of the former and *P. henryi* of the latter. Their similar floral structures also indicate close relationship. In Limpricht's system, however, Polyphyllatae is placed in the "Longirostres Siphonanthae," while Microphyllae is placed remotely in the "Rhyncholophae Alternifoliae," a classification that obscures their relationship by placing them too far apart.

Key to the Species

A. Leaves all alternate; 2 or all 4 of the staminal filaments hairy.
  B. Plant tall, 1.5-2, even sometimes to 5 dm. or more tall; all staminal filaments hairy throughout.
    C. Leaves petiolate, the petioles 0.5-1 cm. or more long, the blades pinnatisect to deeply pinnatifid.
      D. Calyx-teeth short-stipitate, broad, dentate; pedicels shorter, 5-18 mm. long, erect. .... 135. *P. gruina*
      DD. Calyx-teeth very broad, lobulate and dentate, sessile; pedicels very long, about 20-35 mm. long, spreading or reflexed. 136. *P. polyphylloides*
    CC. Leaves subsessile, the blades pinnatifid. .... 137. *P. pinetorum*
  BB. Plants low, hardly to 1.2 dm. tall; posterior staminal filaments glabrous distally.
    C. Calyx-teeth subequal, flabellate and dentate; corolla smaller, about 1.8 cm. long, the tube slightly exceeding the calyx in length; galea hairy dorsally. .... 138. *P. stadlmanniana*
    CC. Calyx-teeth unequal, the posterior one acute and entire, the others flabellate, deeply serrate; corolla larger, about 2.5 cm. long, the tube almost twice as long as the calyx; galea glabrous dorsally. 139. *P. kariensis*
AA. Leaves alternate but sometimes the lower ones opposite; all 4 staminal filaments glabrous. .... 140. *P. limprichtiana*

135. **Pedicularis gruina** Franchet

Key to the Varieties

A. Leaves more or less laxly arranged, distinctly petiolate, the petioles usually longer than 10 mm.
  B. Plant sparsely pubescent; leaf-blade pinnatisect. .... 135a. *P. g. typica*
  BB. Plant more or less densely pubescent; leaf-blade deeply pinnatifid. 135b. *P. g. cinerascens*
AA. Leaves densely arranged, subsessile to short-petiolate, the petioles hardly to 5 mm. long. .... 135c. *P. g. polyphylla*

135a. **Pedicularis gruina typica** Plate 2, fig. 109.

Pedicularis gruina Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 536, fig. 15, 1888, p.p.; in Mél. Biol., 12: 799, fig. 15, 1888, p.p.; Prain, in Journ. As. Soc. Beng., 58 (2): 72, 1889; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 27: 209, 1890, p.p.; Bonati, in Notes Bot. Gard. Edinb., 5: 81, 1911; 7: 81, 157, 1912; 15: 162, 1926; Limpricht, in Repert. Sp. Nov. Beih., 12: 484, 1922; in Repert. Sp. Nov., 20: 244, 1924, p.p.; 23: 337, 1927; Hand.-Maz., Symb. Sin., 7: 860, 1936. Two specimens were originally cited: "Yunnan, prope Li-kiang in paludibus, nec non quercetis cacumine montis Che-tcho-tze supra Ta-pin-tze,—posterior forma cinerascens foliis pinnatipartis (Delavay! in herb. Paris)." Evidently the first specimen is to be recognized as the type. This particular number has not been seen. Several other collections of Delavay made in nearby localities, and undoubtedly also studied by Franchet at later dates, are in the Bonati Herbarium. The second collection, indicated originally as differing from the type by the cinerascent habit and pinnatiparted leaves, is represented by a duplicate in the Bonati Herbarium. This is *Delavay* 336, the type of var. *cinerascens* Franch. described below. In the original description and illustration the calyx is shown to be uncleft anteriorly. Among all the specimens studied, however, the calyx is slightly cleft anteriorly. In the description of *P. polyphylla* the calyx is also not described as to whether or not it is cleft anteriorly, but the illustration given at the side of *P. gruina* shows it as cleft anteriorly. This species resembles in all respects *P. gruina* in floral structures and is here reduced to a variety of the latter.

Alpine meadows at altitudes of 2600 to 3000 meters in northwestern Yunnan. Flowers reddish purple. Flowering in August, September and October.

YUNNAN: Mo-so-yn, *Delavay* s.n. (ANSP, NTU, NYBG, UCLA); Yen-tze-hay, *Delavay* s.n. (UCLA); Hee-chan-men, *Delavay* 200 (ANSP, UCLA); eastern slopes of Likiang Snow Range, *Rock* 10662 (ANSP, UC, USNH); Wei-si District, *Tsai* 57877 (AA), 57986 (AA), *C. W. Wang* 67612 (AA); no data, *Tsai* 57703 (AA).

135b. **Pedicularis gruina cinerascens** Franchet in herb., var. nov.

Pedicularis margaritae Bonati, in Notes Bot. Gard. Edinb., 5: 81, pl. 70, 1911; 7: 243, 1912; Limpricht, in Repert. Sp. Nov., 20: 245, 1924. The type was from northwestern Yunnan: "'Open, grassy situations amongst scrub on the eastern flank of the Tali Range. Lat. 25° 40'. Alt. 9,-10,000 ft. June-July 1906.' G. Forrest No. 4504." It has not been seen. Bonati originally compared it with *P. cephalantha* and *P. longipetiolata*, and accordingly Limpricht included it in the Oliganthae. But clearly its characters, especially the lax long racemose inflorescences and the pinnatifid leaves, show that it is not related to these species and should not be included in the Oliganthae. Instead, this species both from the description and illustration, is possibly identical with the plant here referred to as *P. gruina cinerascens*. The name is here tentatively placed in the synonymy of the latter. An examination of the type material is necessary for its confirmation.

A typo speciei differt indumento dense cinerascente pubescente; foliis profunde pinnatifidis.

Type, Che tscho tze above Tapintze, northwestern Yunnan, collected in flower by Delavay, No. 336; holotype in the Bonati Herbarium to be deposited at the University of California at Los Angeles.

Mountain sides at an altitude of about 2600 meters, in northwestern Yunnan. Flowers rose. Flowering in September and October.

YUNNAN: Che tscho tze above Tapintze, *Delavay* 336 (UCLA); Lan-ping District, *Tsai* 54056 (AA), 56010 (AA).

Among the two original collections of Delavay cited for *P. gruina* Franch., the second one from Tapintze was indicated by the author as representing a different form. In the Bonati Herbarium this number, *Delavay* 336, bears the name *P. gruina* Franch. var. *cinerascens* Franch., apparently in Franchet's own handwriting. This name, so far as I can ascertain, has never been formally published. The only occasion of mentioning the name, but without authority, was by Bonati, in Notes Bot. Gard. Edinb., 5: 88, 1911, when he compared his newly described *P. stadlmanniana* with it. He apparently based this on the specimen in his possession.

This variety is similar to the typical form of the species except that it is more densely cinerascent-pubescent and its leaves are less deeply cut, being profoundly pinnatifid rather than pinnatisect.

135c. **Pedicularis gruina** var. **polyphylla** (Franch.) comb. nov.

Pedicularis polyphylla Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 543, fig. 16, 1888; in Mél. Biol., 12: 809, fig. 16, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 213, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 80, 1911; 7: 242, 1912; Limpricht, in Repert. Sp. Nov., 20: 245, 1924; Hand.-Maz., Symb. Sin., 7: 861, 1936. The type was from: "Yunnan, prope Lankong monte Hee-chan-men, 3000 m.s.m. (Delavay! in herb. Paris)." A specimen is at the New York Botanical Garden.

Alpine meadows at altitudes of about 2800 to 3000 meters in northwestern Yunnan. Flowers purple. Flowering in July.

YUNNAN: Hee-chan-men, *Delavay* 206 (NYBG), 3067 (GH); Tali Range, *Forrest* 11693 (UC); Shweli-Salween divide, *Forrest* 11769 (UC); Pin-chuan District, *Tsai* 52994 (AA).

This variety is similar to the typical form of the species except that the leaves are more numerous, very dense and shorter-petiolate (the petioles hardly to 5 mm. long).

136. **Pedicularis polyphylloides** Bonati Plate 2, fig. 110.

Pedicularis polyphylloides Bonati, in Notes Bot. Gard. Edinb., 8: 38, 1913; 15: 162, 1926; Limpricht, in Repert. Sp. Nov., 20: 244, 1924; 23: 337, 1927; Hand.-Maz., Symb. Sin., 7: 861, 1936. The types were from northwestern Yunnan: "'Semi-prostrate plant of 6-20 inches. Flowers rose. Dry, open situations in pine forests on the eastern flank of the Lichiang Range. Lat. 27° 30′ N. Alt. 10,000 ft. August 1910.' G. Forrest. No. 6321. 'Eastern flank of the Lichiang Range. Lat. 27° 30′ N. Alt. 12,000-13,000 ft. August 1910.' G. Forrest. No. 6405a." A duplicate of *Forrest* 6321, from the Bonati Herbarium, is divided between the University of California at Los Angeles and the Academy of Natural Sciences of Philadelphia.

Pedicularis polyphylla Franch. var. *pilosa* Bonati, in Notes Bot. Gard. Edinb., 5: 80, 1911; 7: 149, 1912; Limpricht, in Repert. Sp. Nov., 20: 245, 1924. The type was from northwestern Yunnan: "'Open, grassy situations amongst scrub on the eastern flank of the Lichiang Range. Lat. 27° 15′. Alt. 10-11,000 ft. July 1906.' G. Forrest. No. 2640." An isotype, from the Bonati Herbarium, is divided between the University of California at Los Angeles and the Academy of Natural Sciences of Philadelphia. It bears Bonati's original identification as *P. polyphylla pilosa* as well as a later one as *P. polyphylloides*. The identity of this variety with Bonati's later species is certain.

Dry open situations in pine forests at altitudes of about 3300 to 3500 meters, in northwestern Yunnan. Flowers rose. Flowering in July and August.

YUNNAN: Likiang, *Schneider* 1916 (USNH); eastern flank of the Likiang Range, *Forrest* 2640 (ANSP, NTU, UCLA), 6321 (ANSP, UCLA), *Rock* 5737 (NYBG, USNH); Lotso Lo. between Likiang, Youngning and Youngpei, en route to Mili, *Rock* 5306 (ANSP, GH, UC, USNH); Likiang Snow Range, *Ching* 20984A (AA), 21289 (AA), 30516 (AA).

This species is related to *P. gruina*, differing chiefly in the long-pilose habit, broader, sessile and lobulate calyx-teeth, and more especially in the long (20-35 mm.) pedicels. The lower corolla-lip is also broader, with the margins more or less very finely ciliate.

137. **Pedicularis pinetorum** Handel-Mazzetti

Pedicularis pinetorum Hand.-Maz., Symb. Sin., 7: 861, pl. 15, figs. 12-14, 1936. The type, from "NW-Y[unnan]: Föhrenwälder der wtp. St. [warmtemperierte Stufe] ober Tschwadse am nordende der Lidjianger Schleife des Yangtze zwischen Yungning und Dschungdien, Kalk, 2500 bis 2800 m, 12. VIII. 1915 (7624)," has not been seen.

In northwestern Yunnan. Flowers reddish. Flowering in August. Known from the original collection only. No specimen seen.

From the description and illustration this species appears to be very close to *P. gruina*, especially var. *cinerascens*. *P. gruina* has pinnatisect leaves, the var. *cinerascens* deeply pinnatifid leaves. In *P. pinetorum*, the leaves are incised to less than one-half the length from the margins to the midrib. It may be that this species is only a variety of *P. gruina* with less cut and more sessile leaves, but without access to type specimens it is here retained as a separate species.

138. **Pedicularis stadlmanniana** Bonati Plate 3, fig. 111.

Pedicularis stadlmanniana Bonati, in Notes Bot. Gard. Edinb., 5: 87, pl. 75, 1911; 7: 24, 1912; Limpricht, in Repert. Sp. Nov., 20: 244, 1924. The type was from northwestern Yunnan: "'Plant of 2-8 inches. Flowers pale rose. Grassy openings in pine forests on the eastern flank of the Tali Range. Lat. 25° 40′ N. Alt. 8-10,000 ft. July 1906.' G. Forrest. No. 4488." Isotypes, from the Bonati Herbarium, pass to University of California at Los Angeles and the Academy of Natural Sciences of Philadelphia.

Grassy openings in pine forests at altitudes of about 2440 to 3050 meters in northwestern Yunnan. Flowers pale rose. Flowering in July. Known from the original collection only.

YUNNAN: eastern flank of the Tali Range, *Forrest* 4488 (ANSP, UCLA).

This species is very similar to *P. kariensis* in general habit but has more delicate stems and much smaller flowers. The galea differs also in being pilose dorsally. In this respect it resembles *P. gruina* and *P. polyphylloides*, from both of which, however, it differs conspicuously in the low habit.

Bonati described the staminal filaments as all hairy, the anterior ones being more densely so. The type specimens show that though the filaments are all hairy near the base, the posterior ones are glabrous distally.

139. **Pedicularis kariensis** Bonati Plate 3, fig. 112.

Pedicularis kariensis Bonati, in Notes Bot. Gard. Edinb., 13: 120, 1921; Limpricht, in Repert. Sp. Nov., 20: 244, 1924. The type was from: "'West China:—Open moist stony pasture on the Kari Pass, Mekong-Yangtze divide. Lat. 27° 40′ N. Alt. 13,000 ft. Plant of 2-3 ins. Flowers deep rose. Aug. 1914.' G. Forrest. No. 13,070." Two duplicates, from the Bonati Herbarium, pass to the University of California at Los Angeles and the Academy of Natural Sciences of Philadelphia.

Open, moist, stony pastures at an altitude of about 3960 meters in northwestern Yunnan. Flowers deep rose. Flowering in August. Known from the original collection only.

YUNNAN: Kari pass, Mekong-Yangtze divide, *Forrest* 13,070 (ANSP, UCLA).

A species very similar to *P. stadlmanniana* in habit but it is more robust, with much shorter pedicels (1-2 mm. long) and larger corolla, the tube being much longer than the calyx, and the galea glabrous dorsally. The calyx-teeth also differ in the posterior one being acute and entire and the lateral ones being longer, broader and pinnatisect.

Bonati described the calyx as " antice vix fissus," but in his key he said: " calyx more or less deeply cut in front." The type specimens show that the calyx is distinctly cleft anteriorly. He also described the staminal filaments as all villose. While the filaments are all hairy proximally, only the anterior filaments are hairy throughout, and the posterior ones are glabrous distally.

140. **Pedicularis limprichtiana** Handel-Mazzetti

Pedicularis limprichtiana Hand.-Maz., in Anz. Akad. Wiss. Wien, Math.-Nat. Kl., 62: 239, 1925; Symb. Sin., 7: 860, fig. 25,C, 1936; Limpricht, in Repert. Sp. Nov., 23: 337, 1927. The type was from southeastern Sikang: " Prov. Setschwan austro-occ.: In montis Lungdschu-schan ad urbem Huili reg. temperata in cespite lapidoso et ad bambuseta, s[olo] diabasico, 3100-3400 *m*, legi 16. IX. 1914 (Nr. 5175)." It has not been seen. Handel-Mazzetti in 1936 cited the following additional specimens from northeastern Yunnan: *Schoch* 277 p.p., *Mell* s.n., and *Maire* s.n., none of which has been seen.

At altitudes of 2100-3400 meters in southeastern Sikang and northeastern Yunnan. Flowers rose. Flowering from July to September. No specimen seen.

Handel-Mazzetti was uncertain about the relationship of this species. He first included it in the Furfuraceae but later (1936) placed it in the Polyphyllatae. He suggested its relationship as with *P. cephalantha*, *P. gruina* and *P. hemsleyana*. In the absence of type or authentic specimens, its exact status cannot be determined.

SECTION XIII. HAPLOPHYLLUM

Usually tall, erect plants; stems often branching at base, simple or branched above; leaves radical or cauline, sessile to petiolate, ovate to lanceolate, crenate to shallowly pinnatifid; flowers usually in compact spikes, rarely in racemes, many-flowered; calyx cleft or not anteriorly, 3-5-dentate, the teeth entire to serrate; corolla with the tube erect, about as long as the calyx or slightly longer; galea erect proximally, falcate distally, the apex obtuse, bidentate or beaked, the beak when present short- to long-conical.

This section is characterized by the simple, either crenate or shallowly pinnatifid leaves. The corolla varies from toothless to toothed or short-beaked. From this section the Phyllomania are probably derived, the leaves becoming more dissected and the beak usually more manifest. Geographically this section extends from Europe through Siberia to the Himalayas, western China and on to North America, but the majority of the species are concentrated in the eastern Himalayas and western China with a few extending southward to southern India and Ceylon.

Series 39. Tsekouenses ser. nov.

Plant of medium size, the stem many-branched at base with a rosette of basal leaves; radical leaves long-petiolate, the petioles slightly winged, the blades membranaceous, elliptic-lanceolate, villose, obtuse, the base cordate, the margins pinnatifid, the lobes obtuse, the base widened, the margins crenate; cauline leaves absent or very few, similar to the radical ones but smaller and shorter petiolate; flowers large, in short spikes, the lower short-pedicillate, erect; bracts foliaceous, membranaceous, petiolate, the upper flabellate to triangular, 3-5-lobed; calyx membranaceous, 5-dentate, the teeth very unequal, the posterior one small, triangular, entire, the others linear-oblong, sharply dentate; corolla large, pale yellowish to rose-colored and often purple-spotted, densely hairy distally, the tube about as long as the calyx, cylindric; galea erect, falcate, obtuse, the lower margins glabrous and entire; lower lip long, stipitate proximally, 3-lobed, the middle slightly larger and distad, attenuate; stamens inserted at the middle of the tube, 2 of the staminal filaments hairy distally; anthers with apex apiculate.

One species in northwestern Yunnan and southern Sikang (Map 20).

This series differs from the Gloriosae in which Bonati originally placed his species in the very unequal calyx-teeth which are distinctly dentate except the posterior one, the falcate galea, which is hairy in front and not on the margins, the deeply lobed lower lip, and the hairy anterior filaments.

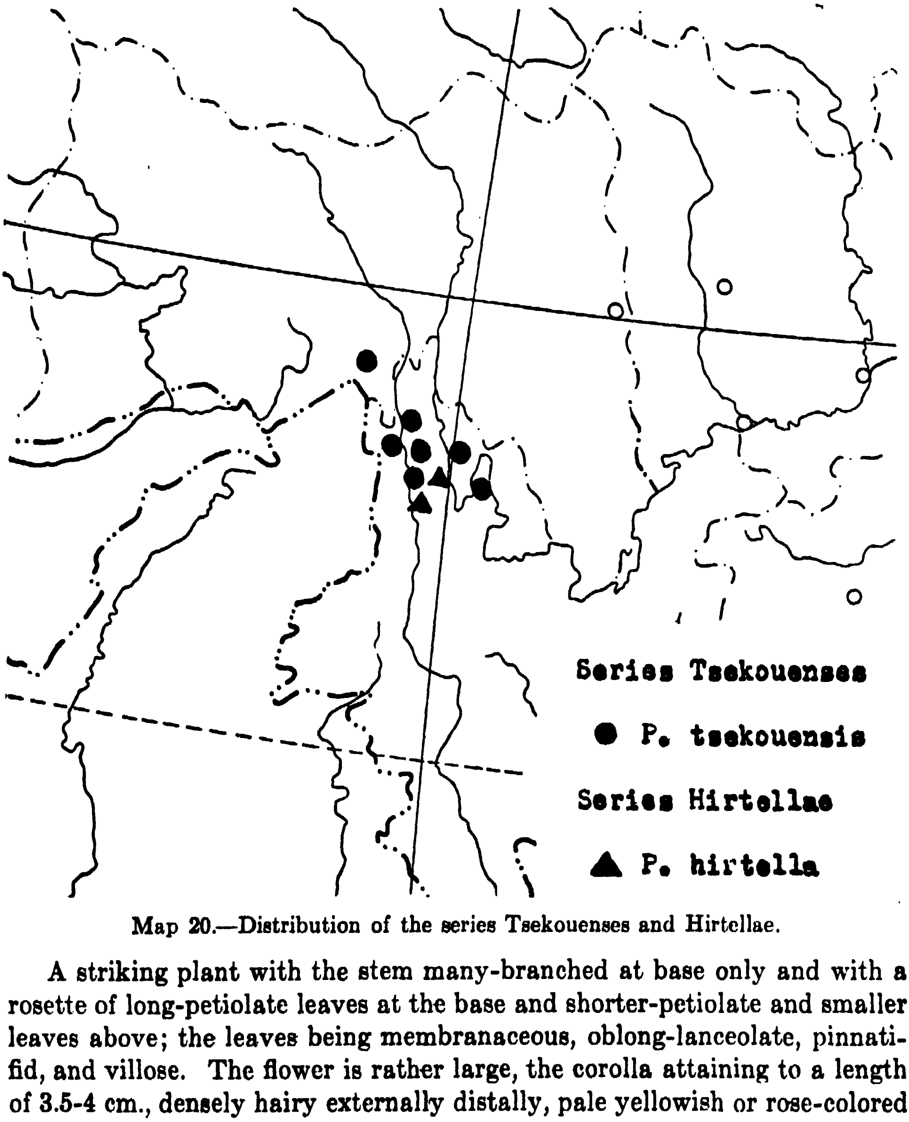
141. **Pedicularis tsekouensis** Bonati Plate 3, fig. 113.

Pedicularis tsekouensis **Bonati, in Bull. Soc. Bot. France, 54: 373, 1907; in Notes Bot. Gard. Edinb., 15: 147, 1926; Limpricht, in Repert. Sp. Nov., 23: 333, 1927; Staff Bot. Gard. Edinb., in Notes Bot. Gard. Edinb., 17: 76, 1929; Hand.-Maz., Symb. Sin., 7: 849, 1936. Bonati's type was from Yunnan: "Tsekou, 1903, n° 1087, *Soulié*," and is in the Paris Museum. An isotype, in the Bonati Herbarium, passes to the University of California at Los Angeles.**

Dry stony pastures among pine and rhododendron scrub at altitudes of 3050 to 4200 meters in Sikang and northwestern Yunnan. Flowers yellow to rose, often with purple dots. Flowering from June through September.

SIKANG: Chawchi Pass, *Farrer* 1899 (RBGE); Tsarung, Solo-la, *Rock* 22688 p.p. (UC); Tsarung, Mt. Wuli-la, *Rock* 22398 (NYBG, UC).

YUNNAN: Tseku, *Soulié* 1087 (UCLA); Tong Shan in the Yangtze bend, *Forrest* 10838 (ANSP, UC, UCLA); Mekong-Salween divide, *Forrest* 13294 (ANSP, NTU, UCLA); Mount Shwemenkan, between the Chungtien River and the Yangtze, northeast of the Likiang Snow Range, *Rock* 9730 (ANSP, GH, UC, USNH); mountains of Nakela, east of Yaragan, Mekong-Salween divide, *Rock* 23116 (CM, MBG, NYBG, UC, UP, USNH); Sila, Mekong-Salween divide, *Yü* 22186 (AA), 22333 (AA), 22369 (AA); Lunguailaka, Salween-Kiukiang divide, *Yü* 20331 (AA); Tsukuai, Salween-Kiukiang divide, *Yü* 20718 (AA); Kung Shiang-shu Snow Mountains, southeast of Hsiao Chungtien, *Feng* 1763 (AA); northern flank of Haba Snow Range, *Feng* 2206 (AA); no data, *Yü* 12299 (AA), *Forrest* 28808 (ANSP), 30592 (ANSP).



Map 20.—Distribution of the series Tsekouenses and Hirtellae.

A striking plant with the stem many-branched at base only and with a rosette of long-petiolate leaves at the base and shorter-petiolate and smaller leaves above; the leaves being membranaceous, oblong-lanceolate, pinnatifid, and villose. The flower is rather large, the corolla attaining to a length of 3.5-4 cm., densely hairy externally distally, pale yellowish or rose-colored and often spotted with purple. The calyx is membranaceous, about 1 cm. long, 5-dentate, the teeth being unequal, with the posterior one smaller, triangular and entire, and the rest linear-oblong and dentate. Two of the filaments are pilose distally.

Fruits of this species have been previously unknown. Among the specimens cited above, *Rock* 22688, *Yü* 20331 and 20718 are fruiting specimens. The capsules are brownish, oblong-ovoid, compressed to 1.2 cm. long and 8 mm. wide, obliquely acuminate and mucronate. The seeds are grayish.

Series 40. Hirtellae

Hirtellae Prain, in Ann. Bot. Gard. Calcutta, 3: 89, 1890.

Tall; stem erect, rigid, unbranched, reddish-hirtellous, distally glandular; leaves mostly radical, large, short-petiolate, the cauline leaves small, subsessile, pinnatifid, the segments obtuse, incised-serrate; inflorescences racemose, elongate, many-flowered, lax; bracts ovate-lanceolate, sparsely denticulate, the posterior tooth more linear and smaller; corolla creamy to rosy, glanduliferous externally, the tube longer than the calyx, erect, the galea erect proximally, rounded and vertical in front, distinctly subulate-dentate at apex; lower lip shorter than the galea, shortly 3-lobed, the lobes rounded, subequal; staminal filaments all glabrous; stigmas slightly exserted.

One species in northwestern Yunnan (Map 20).

Prain distinguished the species *P. hirtella* from other species of the series Striatae to which it was referred by Limpricht and Bonati. The Hirtellae are distinguished as a series by the rosette of basal leaves which are pinnatifid, and the glandular hairs on the leaves, calyces and corollae.

142. **Pedicularis hirtella** Franchet Plate 3, fig. 114.

Pedicularis hirtella Franch. ex Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 209, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 88, 1911; 7: 191, 1912; 8: 42, 1913; 15: 150, 1926; Limpricht, in Repert. Sp. Nov., 20: 216, 1924; 23: 334, 1927. The type, "Yunnan: in bushy places, mount Heechanmen (Delavay, 2729!) Herb. Kew," has not been seen. Description distinctive.

Open stony pastures at altitudes of 3350 to 3660 meters, in northwestern Yunnan. Flowers cream colored, flushed and tipped rose. Flowering from April to September.

YUNNAN: no precise locality, *Forrest* 18838a (UC[3]); eastern slopes of Likiang Snow Range, *Forrest* 6702 (UCLA); Mekong-Salween divide, *Forrest* 13390 (ANSP, UCLA); western slope of Likiang Snow Range, Yangtze watershed, *Rock* 10877 (ANSP, UC, USNH); Yunpe, *Ten* 56 (RBGE).

Limpricht (l.c., 1924) and Bonati (l.c., 1926) included this species in the series Striatae. Prain created for it the series Hirtella. In view of the very distinct characters it seems desirable to follow Prain's segregation.

This species is very strikingly characterized by its rosette of large, radical, short-petiolate, oblong, pinnatifid leaves, the plant reddish hirtellous-pubescent and glanduliferous distally, the calyx and corolla glandular-hairy and the strongly vertical-fronted galea with large subulate teeth. Franchet originally described the 5 calyx-teeth as 2 triangular-lanceolate and 3 linear, and all denticulate. Among the specimens examined, the teeth are all more or less triangular with the posterior one linear and smaller than the others.

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[3] Two sheets of *Forrest* 10838 are in the herbarium of the University of California. One with the original label is the same as the one in the Bonati Herbarium, and is a specimen of *P. tsekouensis*. Another without the original label is *P. hirtella*. This may be a mistake in transcribing the collector's number to the mounted sheet and is here numbered as *10838a*.

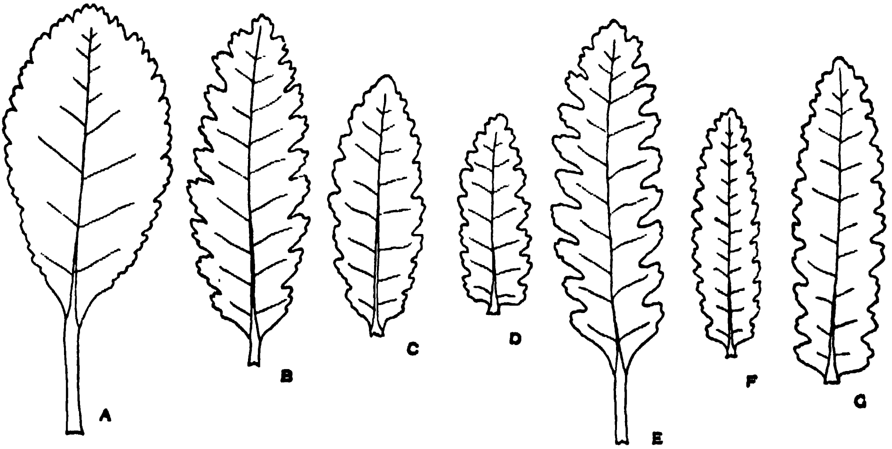
Series 41. Carnosae

Carnosae Prain, in Ann. Bot. Gard. Calcutta, 3: 77, 1890.

Erect, branching plants, the branches more or less slender, pubescent to glabrate; leaves alternate, carnose to chartaceous, subsessile to short-petiolate, ovate to linear-oblong, the apex acute to obtuse, the base attenuate to subcordate, the margins shallowly to deeply crenate, the teeth dentate; bracts foliaceous; flowers spicate, more or less compact; calyx membranaceous, slightly or scarcely reticulate, cleft anteriorly or entire, 2-dentate, the teeth entire or serrate, sometimes 2-lobed; corolla erect, the tube longer than the calyx, erect, slightly enlarged distally; galea recurved distally, erect proximally, terminating in a very short to distinct beak; lower lip 3-lobed, the lobes equal to unequal, glabrous or ciliate on the margins; staminal filaments glabrous or very sparsely hairy; stigmas exserted; capsules ovoid, slightly exserted.

About 8 species, in the eastern Himalayas, Sikang, and Yunnan, south to India and Ceylon (Map 21).

As an aid to the identification of species the general outlines of the leaves, which resemble each other closely, but nevertheless can be clearly distinguished, are illustrated in text-figure 5.

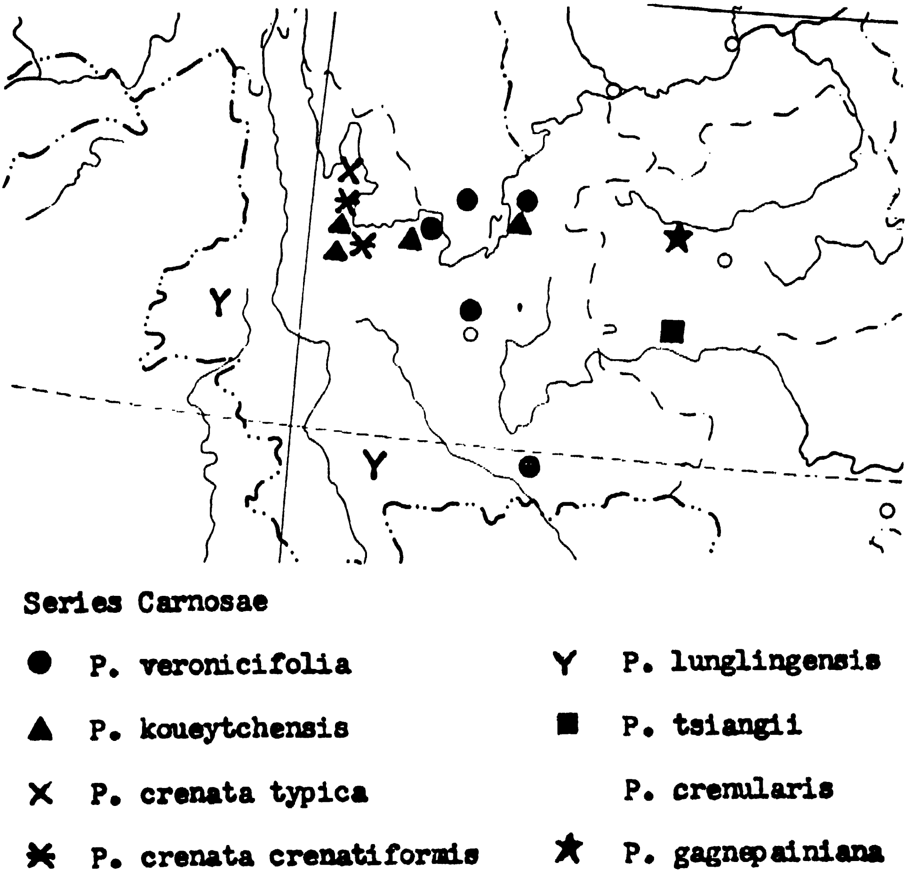


Text-figure 5.—Leaves of the series Carnosae. A, *P. veronicifolia* Franch. B, *P. kouytchensis* Bonati. C, *P. crenata* Maxim. var. *typica*. D, *P. crenata* Maxim. var. *crenatiformis* Bonati. E, *P. lunglingensis* Bonati. F, *P. tsiangii* Li. G, *P. crenularis* Li.

Key to the Chinese Species

A. Leaves distinctly petiolate, the blade broadly ovate to oblong, the base long-attenuate; staminal filaments all glabrous.

  B. Beak long, slender, about 3.5 mm. long; lower lip of the corolla ciliate on the margins. .... 143. *P. bifida*



Map 21.—Distribution of the series Carnosae.

BB. Beak short but distinct, about 1-2 mm. long; lower lip of the corolla glabrous on the margins.

C. Plant slightly pubescent; leaves often obovate, 2-3 cm. wide, shallowly crenate; calyx deeply cleft anteriorly, the teeth narrow, subentire; corolla larger, about 3 cm. long, the beak 2 mm. long. 144. *P. veronicifolia*

CC. Plant densely pubescent; leaves ovate-oblong, 1.5-1.8 cm. wide, more deeply crenate-dentate; calyx scarcely cleft anteriorly, the teeth broad, serrate; corolla smaller, about 2.5 cm. long, the beak about 1 mm. long. 145. *P. koueytchensis*

AA. Leaves petiolate to sessile, the blade narrower, oblong to linear-oblong, the base broader, attenuate to subcordate; staminal filaments all sparsely hairy or at least the anterior ones sparsely hairy.

B. Calyx not cleft anteriorly, the teeth often 2-lobed; corolla about 2.2 cm. long, the beak more distinct, about 1.5 mm. long, the lobes of the lower lip rounded; anterior filaments sparsely hairy. .... 146. *P. crenata*

BB. Calyx cleft anteriorly, the teeth not 2-lobed; corolla about 3.5 cm. long, the beak inconspicuous, scarcely 1 mm. long, the lobes of the lower lip more or less acute; all staminal filaments sparsely hairy.

C. Leaves petiolate, the blades deeply crenate, the base attenuate; galea more erect and less curved distally, the beak scarcely conspicuous. 147. *P. lunglingensis*

CC. Leaves sessile to subsessile, shallowly crenate, the base broad, often subcordate; galea strongly falcate above, the beak more distinct.

D. Leaves smaller, to 3.5 cm. long and 9 mm. wide, with 12-13 teeth on each side; galea prominently falcate. .... 148. *P. tsiangii*

DD. Leaves larger, to 4 cm. long and 1.2 cm. wide, with about 10 teeth on each side; galea shortly curved distally. .... 149. *P. crenularis*

Status uncertain. .... 150. *P. gagnepainiana*

143. Pedicularis bifida (Buchanan-Hamilton) Pennell

Rhinanthus bifidus Buch.-Ham., in Don, Prodr. Fl. Nepal., 94, 1825. "Hab. ad Narainhetty Nepalensium. *Hamilton* [in 1802-03]." Identified by Prain (in Ann. Bot. Gard. Calcutta, 3: 152, 1890) from the original sheet as the species now considered.

Pedicularis carnosa Wall., List 418, 1828; Pl. As. Rar., 2: 44, pl. 154, 1831; Maxim., in Bull. Acad. St. Pétersb., 32: fig. 52, 1888; in Mél. Biol., 12: fig. 52, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 205, 1890; Limpricht, in Repert. Sp. Nov., 239, 1924. Wallich's type was from Nepal: "Crescit in monte Sheopur Napaliae. . . . I have found this handsome species only on Mount Sheopur in Nepal, toward its summit, where it blossoms in the rainy season about August. The flowers are . . . of a bright rose colour, with a white tube, the point of the upper lip crimson, almost purple." Named for the fleshy root-fibers.

Pedicularis bifida (Buch.-Ham.) Pennell, in Monogr. Acad. Nat. Sci. Phila., 5: 144, 1943. Pennell adopted Buchanan-Hamilton's name which apparently refers to the strongly cleft calyx, on the basis of Prain's positive identification of the original material in the Calcutta Herbarium.

From western to eastern Himalayas and northwestern Yunnan (?). No Chinese specimens seen.

The only Chinese record for this Indian species is that given by Forbes & Hemsley, citing *Delavay* s.n. from Tsang-shan above Tali. This same record was repeated by Limpricht. This particular number has not been seen. Neither can any other later collection be referred to this species. The occurrence of this species in China is therefore somewhat doubtful.

144. Pedicularis veronicifolia Franchet Plate 3, fig. 115.

Pedicularis veronicifolia Franch., in Bull. Soc. Bot. France, 47: 30, 1900; Limpricht, in Repert. Sp. Nov., 20: 240, 1924, p.p.;[4] 23: 337, 1927; Hand.-Maz., Symb. Sin., 7: 860, 1936. Franchet originally cited several numbers: "Yunnan, sûr la montagne de Pee-ngui-tze (Delavay, n. 330); mont Yo-lin-chan (id.), mont Pee-tsao-long-chan (Delavay, n. 6644), Yunnan sen (Bodinier et Ducloux, n. 438)." Of these collections only one sheet, a duplicate of *Delavay* 6644, in the Bonati Herbarium, and passing to Academy of Natural Sciences of Philadelphia, has been seen. On this particular sheet there are four specimens representing two different elements. One of the specimens is clearly *P. veronicifolia* while the other three are *P. koueytchensis*. It is uncertain whether the original sheet of the same number studied by Franchet has similarly mixed elements.

Grassy slopes at altitudes of 1600 to 2600 meters in eastern to southern Yunnan, and southeastern Sikang. Flowers rose or white with rose beak. Flowering from August to October.

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[4] Limpricht also cited *Forrest* 4676, apparently based on Bonati's earlier identification (Bonati, in Notes Bot. Gard. Edinb., 5: 85, 1911; 7: 259, 1912), as representing *P. veronicifolia*. Bonati mentioned that "This is a more hairy form with filaments slightly bearded at the base and larger flowers"; it has proved to be *P. koueytchensis*.

SIKANG: Hui-li District, *Yü* 1615 (GH); Muli, *Ward* 4945 (RBGE).

YUNNAN: no precise locality, *Maire* s.n. (ANSP, NTU, UCLA); Pee tsao long chan *Delavay* 6644 p.p. (ANSP); Mengtze, *Henry* 9821 (USNH), 9821 A (MBG, NYBG); Yunnan sen, Tchang chan, *Ducloux* 697 (ANSP, USNH), 700 (ANSP, NTU, UCLA); Tong Tchouan, *Maire* 3526 (ANSP, NTU, UCLA, USNH); Yunpe, *Ten* 16 (RBGE).

This species is closely associated with *P. corymbosa* Prain and *P. koueytchensis*. From these two species it can be readily distinguished by its nearly glabrate habit, much broader usually obovate and more shallowly crenate leaves, entire and narrower calyx-teeth, longer lower lip and a more distinct beak.

145. Pedicularis koueytchensis Bonati Plate 3, fig. 116.

Pedicularis koueytchensis Bonati, in Arch. Bot. Caen Bull., 1: 217, 1927. Bonati's type, "Habitat: Chine, pâtures des collines à Tong-Tchouan, alt. 2.550 m.; fleurs roses; septembre 1920 (E. E. Maire)," has not been seen. In the Bonati Herbarium there are a number of specimens collected by Maire at this same locality but at earlier dates, that were labeled *P. veronicifolia* by Bonati. These agree very closely with the original description of Bonati's later species, *P. koueytchensis*. These two species, as mentioned by Bonati, were frequently mixed together in collections from the same locality. The origin of the specific name is not clear. It may be that Bonati named the species for the province of Kweichow which in French is often spelled "Kouey-Tcheou"; but the original locality, Tung Chuan, is in the northeastern part of Yunnan.

"*Pedicularis crenata*" *sensu* Limpricht, in Repert. Sp. Nov., 20: 239, 1924, p.p.; Hand.-Maz., Symb. Sin., 7: 859, 1936, p.p.; *non* Maxim. Limpricht and Handel-Mazzetti cited *Schneider* 2724 and *Schoch* 376 respectively, which are *P. koueytchensis* Bonati. The differences between the two species have been noted under both entities.

Stony mountain pastures at altitudes of 2800 to 3350 meters in northwestern to northeastern Yunnan. Flowers rose purple. Flowering from July to October.

YUNNAN: Pee tsao long chan, *Delavay* 6644 p.p. (ANSP); Tong Tchouan, *Maire* 3491 (ANSP, NTU, UCLA), 6143 (ANSP, NTU, UCLA); Mount Tsang near Tali, *Schneider* 2724 (GH); Chan yi chow, *Schoch* 376 (USNH); eastern flank of the Tali Range, *Forrest* 4676 (ASNP, NTU, UCLA).

This species is closely related to *P. veronicifolia* but differs readily in the much more deeply crenate leaves, the serrate instead of entire calyx-teeth, and the smaller corolla. From *P. crenata* it can be distinguished by its broader, more distinctly crenate leaves which are mostly short-petiolate, the serrate calyx-teeth, the much shorter beak and the wholly glabrous filaments.

146. Pedicularis crenata Maximowicz

Key to the Varieties

A. Leaf-base attenuate to rounded; calyx-teeth bilobed. .... 146a. *P. c. typica*
AA. Leaf-base subcordate; calyx-teeth not bilobed. .... 146b. *P. c. crenatiformis*

146a. Pedicularis crenata typica Plate 3, fig. 117.

Pedicularis crenata Maxim., in Bull. Acad. St. Pétersb., 32: 559, fig. 53, 1888; in Mél. Biol., 12: 832, fig. 53, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 207, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 85, 1911; 7: 191, 1912; 8: 41, 1913; Limpricht, in Repert. Sp. Nov., 20: 239, 1924, p.p.; Hand.-Maz., Symb. Sin., 7: 859, 1936, p.p.[5] Maximowicz's type was from northwestern Yunnan: "Yunnan, pratis montium supra Tapin-tze (Delavay! 'fleurs blanches ou roses' in Mus. Paris. ubi sub *P. carnosa* jacebat)." There are two sheets of Delavay in the Bonati Herbarium, both from the herbarium of Paris Museum. One of them is *Delavay* 198, with a single specimen from "Yang in chan" collected in 1883 and another is *Delavay* without number and lacking field notes but with eight specimens. It is possible that the latter is a duplicate sheet of the type collection.

Grassy slopes in northwestern Yunnan. Flowers rose. Flowering in August.

YUNNAN: no precise localities, *Delavay* s.n. (ANSP, UCLA), *Yü* 13508 (AA); Yang in chan, *Delavay* 198 (UCLA); eastern flank of Likiang Range, *Forrest* 3079 (UCLA), 6405 (ANSP).

In the rather long and distinct beak and the slightly ciliate lower lip, this species is most nearly related to *P. bifida* (Buch.-Ham.) Pennell (*P. carnosa* Wall.); but it may be distinguished by the calyx being cleft anteriorly and scarcely reticulate, and in the calyx-teeth being frequently 2-lobed. The leaves are narrower, broader at base, more distinctly crenate, and shorter petiolate. It differs further in the anterior filaments being sparsely hairy distally. From *P. koueytchensis* it can be distinguished by its narrower, more shallowly crenate leaves which are nearly sessile, the bilobed calyx-teeth, the much longer and more slender beak, and the sparsely hairy anterior filaments.

146b. **Pedicularis crenata crenatiformis** Bonati

Pedicularis crenata var. *crenatiformis* Bonati, in Notes Bot. Gard. Edinb., 15: 159, 1926; Limpricht, in Repert. Sp. Nov., 23: 337, 1927; Hand.-Maz., Symb. Sin., 7: 859, 1936. Bonati originally cited three collections: "Yunnan: Yangtze watershed, Prefectural District of Likiang, eastern slopes of Likiang Snow Range, Nguluke, open meadow. Flowers pink. Aug. 1922; J. F. Rock, No. 5875. 'Yunnan: between Likiang and Tali-fu, Lung-kwei Road. Flowers white with purplish tip. Aug. 1922,' J. F. Rock. No. 6318. 'Yunnan: Eastern slopes of Likiang Snow Range, Chu-Hyin-ko, near Nguluke. Flowers purple, among limestone rocks. Alt. 10,000 ft. Sept. 1923.' J. F. Rock. No. 10625." Four sheets of *Rock* 6318 and one of 10625 are available for study. The latter number, however, is an admixture of two elements with a specimen of *P. labordei* together with one of *P. crenata crenatiformis*.

Among limestone rocks at altitudes of about 3350 meters, in northwestern Yunnan. Flowers purple, or white and purple-tipped. Flowering in August and September.

YUNNAN: between Likiang and Tali, Lung-kwei Road, *Rock* 6318 (ANSP, GH, NYBG, UC, USNH); eastern slopes of Likiang Snow Range, Chu Hyin Ko, *Rock* 10625 p.p. (USNH).

This variety differs from the typical form in the slightly narrower and more deeply crenate leaves which are nearly sessile and with subcordate bases. The two calyx-teeth are simple instead of 2-lobed.

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[5] *Schneider* 2724 and *Schoch* 376, identified by Limpricht and Handel-Mazzetti respectively as *P. crenata* Maxim., are actually *P. koueytchensis* Bonati.

147. **Pedicularis lunglingensis** Bonati

Pedicularis lunglingensis Bonati, in Notes Bot. Gard. Edinb., 15: 160, 1926; Limpricht, in Repert. Sp. Nov., 23: 337, 1927. The type was from: "Yunnan: between Camp Yu-Tan-Po and Mau-Lo, between Tengyueh and Lungling. Flowers pink in damp forest. Oct. 1922.' J. F. Rock. No. 7126." Three duplicates of the type collection are available for study, as indicated below.

"*Pedicularis corymbosa*" *sensu* Dunn, in Journ. Linn. Soc. Bot., 39: 473, 1911; *non* Prain. Dunn identified *Henry* 12613 from Szemao, Yunnan, as representing *P. corymbosa* Prain of Upper Burma. One of the syntypes of Prain, from Maymyo Hills, bearing Prain's original label, is in the Dehra Dun Herbarium and is available for study. The specimen together with the original description and illustrations given by Prain show that the Chinese plant is not referrable to the Burmese species. The Chinese plant is much more densely hairy, and the leaves are more profoundly crenate. The staminal filaments are sparsely hairy throughout when young, becoming glabrous or hairy at the base only when old. *P. corymbosa,* however, has glabrous stamens. The Chinese plant, identified by Dunn as *P. corymbosa,* is, in all respects, identical with the plant described by Bonati as *P. lunglingensis.*

Grassy slopes at altitudes of about 1200 to 1500 meters, in southern Yunnan. Flowers rose. Flowering in October and November.

YUNNAN: Szemao, *Henry* 10732 (MBG, NYBG), 12613 (MBG, USNH); between Tengyueh and Lungling, *Rock* 7126 (GH, NYBG, UC).

This species was originally placed by Bonati in the series Myriophyllae, but clearly its proper place is in the Carnosae. In the serrate calyx-teeth this species resembles *P. koueytchensis* to which it is closely related. However, it can be differentiated from the latter by its relatively narrower leaves, more deeply cleft calyx, acute instead of rounded lobes of the lower corolla-lip, and by the galea being almost beakless. The younger flowers have filaments that are very sparsely hairy, while in old flowers the filaments are either wholly glabrous or sparsely hairy at the base only.

148. **Pedicularis tsiangii** sp. nov. Plate 4, fig. 119.

Planta circiter 3.5 dm. alta; caulibus ad basim ramosis, erectis, plus minusve dense pubescentibus; foliis alternis, sessilibus vel subsessilibus, subcarnosis, utrinque pubescentibus, lineari-oblongis, 2-3.5 cm. longis, 6-9 mm. latis, apice acutis, basi rotundatis vel subcordatis, margine leviter crenato-serratis, dentibus utrinsecus 12-13, 1-2 mm. longis, rotundatis, dentatis; inflorescentiis terminalibus spicatis, ad 8 cm. longis, floribus subsessilibus, plus minusve densis; bracteis sessilibus, ovato-oblongis, circiter 2 cm. longis et 6 mm. latis, apice obtusis, basi rotundatis, margine leviter crenatis, utrinque sparse pubescentibus; calyce cylindrico, circiter 1.2 cm. longo et 3 mm. lato, membranaceo, pubescente, prominente 4-5-nervo, vix reticulato, antice fisso, 2-dentato, dentibus flabellatis, irregulariter serratis; corollā roseā, glabrā, circiter 3.5 cm. longā, erectā: tubo circiter 1.8 cm. longo, recto; galeā circiter 1.7 cm. longā, inferne rectā, superne valde falcatā, apice in rostrum brevissimum productā; rostro truncato, vix 1 mm. longo; labio inferiore galeam aequante, 3-lobato, lobis subaequalibus, apice subacutis, margine glabris; staminibus ad tubi basim insertis, filamentis sparse hirsutis, antheris oblongis; stylo subexserto; capsulis ignotis.

Type, open hillside, at an altitude of about 466 meters, in Anlung, Kuchang, in southwestern Kweichow, close to the Kwangsi border, collected in flower, Oct. 19, 1930, by Y. Tsiang, No. 7391; holotype in the herbarium of the New York Botanical Garden. Flowers pink. Only collection seen.

The floral structure of this species indicates relationship with *P. lunglingensis.* Their flowers are about the same size with similar calyx, corolla, and similar more or less acute corolla-lobes. Both have the staminal filaments sparsely hairy in young flowers. In this new species, however, the calyx-teeth are broader and irregularly serrate, the galea bending more strongly distally and ending in a very short but distinct beak. The two species, moreover, differ considerably from each other in their leaf-structure. The leaf-blades of *P. lunglingensis* are larger, more profoundly serrate and with attenuate bases to the long distinct petioles. In this new species the blades are more hairy, shallowly crenate, with broader sometimes subcordate bases that are almost sessile.

149. **Pedicularis crenularis** sp. nov. Plate 4, fig. 120.

"*Pedicularis crenata*" *sensu* Bonati, in Notes Bot Gard. Edinb., 8: 41, 1913, p.p.; *non* Maxim.

Planta circiter 3 dm. alta; caulibus singulis, erectis, superne ramosis, plus minusve dense pubescentibus; foliis alternis, sessilibus vel subsessilibus, subcarnosis, supra tomentosis, subtus dense villosis, lineari-oblongis, circiter 4 cm. longis 1.2 cm. latis, apice acutis, basi rotundatis vel subcordatis, margine profunde crenatis, dentibus utrinsecus circiter 10, rotundatis, crenulatis; inflorescentiis terminalibus spicatis, 3.5-5 cm. longis, floribus subsessilibus, plus minusve densis; bracteis sessilibus, foliaceis, oblongis, circiter 1.5 cm. longis 4-6 mm. latis, obtusis, basi rotundatis, margine crenatis, utrinque dense pubescentibus; calyce cylindrico, extus dense pubescente, 4-5-nervo, paulo vel vix reticulato, antice fisso, 2-dentato, dentibus flabellatis, irregulariter at distincte serratis; corollā roseā (?), glabratā, circiter 3 cm. longā, erectā: tubo circiter 1.8 cm. longo, recto; galeā circiter 1.2 cm. longā, inferne rectā, superne falcatā, apice in rostrum conicum brevissimum productā; rostro truncato, vix 1 mm. longo; labio inferiore galeam aequante, 3-lobato, lobis subaequantibus, obtusis vel subacutis, margine glabris; staminibus ad tubi medium insertis, filamentis parce villosis, antheris oblongis; stylo subexserto; capsulis ignotis.

Type, in Yunnan, precise locality unknown, collected in flower by G. Forrest, No. 7217; holotype in the Bonati Herbarium to be deposited at the University of California at Los Angeles. Only collection seen.

Resembling *P. tsiangii* but differing in the larger leaves, with fewer but more prominent serrations, and in the less curved galea. In these characters it appears to be intermediate between *P. tsiangii* and *P. lunglingensis,* and may be a hybrid between the two. However, the collections in all cases are too meager to warrant such a conclusion. Hybridization, if there is any among the Chinese and Himalayan species, should be first studied carefully in the field.

150. **Pedicularis gagnepainiana** Bonati

Pedicularis gagnepainiana Bonati, in Arch. Bot. Caen Bull., 1: 218, 1927. The type, "Chine, sommet de la montagne entre Houang-Tsao-Po at Kiang-Si, Kouey-Tchéou; fleurs roses; octobre 1918 (Cavalerie No 4143, Herb. Museum Paris)," has not been seen.

In Kweichow. Flowers rose. Flowering in October. Known from the original collection only. No collection seen.

Bonati originally put this species in the series Microphyllae but mentioned that it differs from all species of that series and is transitional between the Rigidae, the Carnosae, and the Microphyllae. From the description, which states that the leaves are crenulate, the calyx 2-lobed, the corolla 40-45 cm. long with the galea ending in a short beak, it evidently belongs more properly to the series Carnosae. In the absence of type material it is impossible to ascertain its exact status. It may be that it is referable to one of the species mentioned above.

Series 42. Racemosae

Racemosae Prain, in Ann. Bot. Gard. Calcutta, 3: 77, 1890.

Tall, erect plants, the stem usually single, mostly branching above, glabrous or more frequently sparsely to densely hairy; leaves alternate, sometimes alternate and opposite or subopposite, membranaceous to chartaceous, sessile to petiolate, ovate to lanceolate, the margins crenate; inflorescences short-spicate; calyx ovate, cleft anteriorly, 2-dentate, the teeth entire to slightly dentate; corolla yellow to purple, the tube more or less straight, exceeding the calyx in length, the galea falcate, the beak distinct, conical, the lower lip about as long as the upper, 3-lobed, the lobes subequal, often ciliate on the margins; filaments hairy or glabrous; stigmas exserted.

About 8 species in Europe, Siberia, western to northern China, Burma, and North America (Map 22).

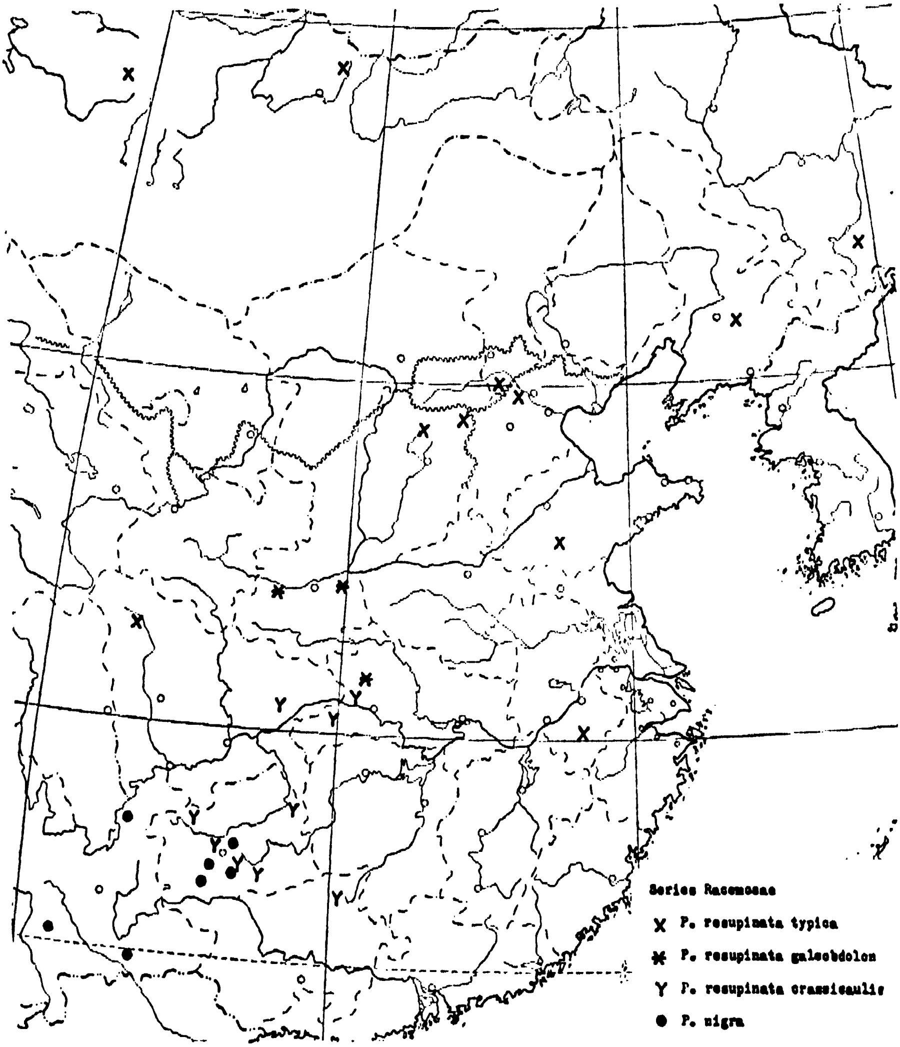
Key to the Chinese Species

A. Plant not blackened when dry, more or less hairy, the leaves ovate-oblong, distinctly serrate; flowers about 2 cm. long; calyx hairy, the teeth broad, entire; anterior staminal filaments hairy. .... 151. *P. resupinata*

AA. Plant blackened when dry, glabrous throughout, the leaves linear-lanceolate to linear-oblong, minutely crenulate; flowers about 2.5 cm. long; calyx glabrous, the teeth narrow, often dentate; all staminal filaments sparsely hairy. .. 152. *P. nigra*

151. **Pedicularis resupinata** Linnaeus

Of this widely distributed species several varieties may be segregated among Chinese plants. In Mongolia, Manchuria, and northern China the typical form of the species occurs. The southern limit of its distribution lies in northwestern Szechuan, Shensi, Hopei, and Shantung; it is also present in southern Anhwei. Farther south occur two varieties: one, *galeobdolon,* in southern Shensi and Hupeh and the other, *crassicaulis* in western



Map 22.—Distribution of the series Racemosae.

Hupeh, eastern Szechuan, Kweichow, and Kwangsi. These varieties, though recognizable, appear conspecific with the typical form of the species that is widely distributed in Europe and northern Asia.

In a study of Manchurian plants, Komarov recognized four forms in *P. resupinata* (in Act. Hort. Petrop., 25: 449, 1909). As the available material from Manchuria and adjacent regions is not extensive no attempt has been made to differentiate these forms.

Key to the Chinese Varieties

A. Plants slightly hairy to nearly glabrous; beak slender, distinct, attenuate.
  B. Leaves chartaceous, more or less hairy on both surfaces; corolla pink to purple. .... 151a. *P. r. typica*
  BB. Leaves membranaceous, glabrate; corolla yellowish. .. 151b. *P. r. galeobdolon*
AA. Plants more or less densely hairy; beak short, truncate. ... 151c. *P. r. crassicaulis*

151a. **Pedicularis resupinata** typica Plate 4, fig. 121.

Pedicularis resupinata L., Sp. Pl., 608, 1753; Maxim., in Bull. Acad. St. Pétersb., 24: 70, 1878; 32: fig. 51, 1888; in Mél. Biol., 10: 106, 1878; 12: fig. 51, 1888; Palabin, in Act. Hort. Petrop., 14: 134, 1895; Franch., in Nouv. Arch. Mus. Hist. Nat. Paris, II, 6: 1883 (Pl. David. I); Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 214, 1890; Diels, in Bot. Jahrb., 29: 572, 1900; Komarov, in Act. Hort. Petrop., 25: 447, 1907; Bonati, in Bull. Soc. Bot. France, 54: 186, 1907; Limpricht, in Repert. Sp. Nov. Beih., 12: 484, 1922; in Repert. Sp. Nov., 20: 237, 1924; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 127, 217, 1934. Linnaeus' type was from Siberia: "Habitat in Sibiria *D. Gmelin. D. Demidoff.*"

Europe to northern China. In China it occurs on grassy slopes at altitudes of 300 to 1600 meters, in Mongolia, Manchuria, Shansi, Chahar, Hopei, Shantung, and Anhwei. Flowers pink to purple. Flowering in July, August, and September.

MONGOLIA: Montes Kentei ad fontes fluviorum Tola, *Ikonnikov-Galitzky* 19 (NYBG); Mongolia and Khangai, *Ikonnikov-Galitzky* 364 (UC).

MANCHURIA: coast of Manchuria, *Wilford* s.n. (USNH); Fengtien, *Faber* s.n. (MBG, NYBG); Hingan, *Dorsett* 3735 (ANSP, NYBG, UC, USNH); Kirin, *Kung* 2133 (NYBG), *F. H. Chen* 349 (NYBG), 554 (GH).

SHANSI: Mount Wu-tai, *Tang* 1086 (NYBG); Ning-wu District, *Tang* 1410 (NYBG).

SZECHUAN: Sung-pan District, *Fang* 4406 (ANSP, GH, NYBG, USNH).

CHAHAR: Hsiao Wu-tai-shan, *Meyer* 1220 (GH, NYBG), *C. F. Li* 10685b (NYBG), 10780 (NYBG), 11060 (NYBG), *J. C. Liu* 1895 (UC), *T. P. Wang* 652 (NYBG).

HOPEI: no precise locality, *J. C. Liu* 927 (UC); Po-hua-shan, *J. C. Liu* 1133 (UC); Hsi-ling-shan, *King* 252 (NYBG, UC).

SHANTUNG: Fei District, Meng Shan, *Cheo & Yen* 104 (GH).

ANHWEI: no data, *Ching* s.n. (NYBG); Woo-tien-shan, Kweichow, *Ching* 9044 (UC, USNH); Huang Shan, *Steward* 7136 (UC, USNH), *Ching* 8649 (UC, USNH).

151b. **Pedicularis resupinata galeobdolon** (Diels) Limpricht

Pedicularis galeobdolon Diels, in Bot. Jahrb., 36, Beibl. 82: 96, 1905. The types were from Shensi and Hupeh: "*N* [Nord-District] Ngo shan—blüh. Aug. 1899; Ki fon shan bei Pao ki seen—blüh. Sept. 1899 (Gi[raldi] 4000, 4001).—*O.* [Ost-District] wahrscheinlich auch Hupeh (He[nry] 6866, in Herb. Berl., etwas mangelhaftes Exemplar)." Two sheets of *Henry* 6866, in fair condition but in fruit only, are available for study.

Pedicularis resupinata var. *galeabdolon* (Diels) Limpricht, in Repert. Sp. Nov., 20: 238, 1924. This combination was effected by Limpricht although he gave Diels as the author.

In southern Shensi and western Hupeh. Flowers yellow. Flowering in August and September.

HUPEH: no locality, *Henry* 6866 (GH, USNH); western Hupeh, Fang District, *Wilson* 2387 (ANSP, NYBG).

151c. Pedicularis resupinata crassicaulis (Vaniot) Bonati

Pedicularis crassicaulis Vaniot ex Bonati, in Bull. Acad. Géogr. Bot., 13: 241, 1904; Limpricht, in Repert. Sp. Nov., 20: 239, 1924; Hand.-Maz., Symb. Sin., 7: 859, 1936. The types were from Kweichow: "Kouy Tchéou, environs de Gan-Pin etc., CC. dans la montagne, Leg. Leon Martin 16, 8, 1897. Herbier Bodinier, nº 1898. Existe aussi à Pin-Fa (R. P. Cavalerie) 4 septembre 1902, no. 395." These have not been seen.

Pedicularis resupinata var. *crassicaulis* (Vaniot) Bonati ex Limpricht, in Rep. Sp. Nov., 23: 330, 1927. This variety of Bonati was first published by Limpricht.

Grassy slopes and thickets at altitudes of 600 to 1500 meters in Kwangsi, Kweichow, Szechuan, and Hupeh.

HUPEH: no precise locality, *Henry* 2547 (USNH), 6523 A (GH); western Hupeh, *Wilson* 2473 (NYBG, USNH); Hsien-shan District, *Y. Chen* 15100 (UC), 15147 (UC); Chienshih District, *Chow* 1338 (NYBG), 1420 (NYBG).

SZECHUAN: eastern Szechuan, *Farges* s.n. (ANSP), 15 (ANSP).

KWEICHOW: no precise locality, *Schoch* 424 (USNH); Pin-fa, *Cavalerie* 2509 (ANSP, UCLA); Tuhshan, *Tsiang* 6530 (NYBG); Kweiyang, *Tsiang* 8661 (NYBG); Pichieh, Tui-po, *Tsiang* 9048 (NYBG); Fan Ching Shan, *Steward, Chiao & Cheo* 397 (NYBG).

KWANGSI: Kwei-lin District, Chi-feng-shan, *Tsang* 28417 (USNH).

Limpricht (l.c., 1924) at first doubtfully referred *P. crassicaulis* to the series Racemosae but later (l.c., 1927) treated it as a variety of the widely distributed *P. resupinata*. Handel-Mazzetti, however, maintained it as a distinct species. He believed that its short beak prevents it from being included in the concept of *P. resupinata*. But besides the length of the beak and its more dense hairiness, both characters tending to intergrade to a certain extent, it resembles the typical form in all other respects so closely as to render its segregation into a separate species hardly justifiable.

152. Pedicularis nigra Vaniot Plate 4, fig. 122.

Pedicularis colletti Prain var. *nigra* Bonati, in Bull. Acad. Géogr. Bot., 13: 240, 1904. The types were from Kweichow: "Kouy-Tchéou, environs de Kouy-Yang, mont du Collège, gorges de Yang-pa. Se trouve aussi sur la route de Kouang-Chouen à Tsin-Gay, gorges de la montagne Leg. Bodinier, 14.8. 98. no. 2509 et Leg. Laborde 17 août 1899." A photograph of the first collection, unnumbered and without field notes but bearing the original handwritings of both Vaniot and Bonati, is in the Gray Herbarium. Bonati gave Vaniot as the author of this variety, but as the labels show Bonati himself was the author of this as a variety, while Vaniot had only named it *P. nigra;* this last is now the accepted name since we accord the plant specific status. See discussion below.

Pedicularis nigra Vaniot ex Bonati, in Bull. Acad. Géogr. Bot., 13: 241, 1904, in syn sub. *P. colletti* Prain var. *nigra;* Vaniot ex Bonati, in Notes Bot. Gard. Edinb., 13: 129, 130, 1921; Limpricht, in Repert. Sp. Nov., 20: 238, 1924; Hand.-Maz., Symb. Sin., 7: 859, 1936.

Pedicularis tongtchouanensis Bonati, in Notes Bot. Gard. Edinb., 13: 129, 1921; Limpricht, in Repert. Sp. Nov., 20: 238, 1924. The type, "East Yunnan:—'Hautes montagnes à Tong-Tchouan. Alt. 3,200 m. Pedicularis vivace, feuilles de la base en rosette; fl. blanc lavé de rose. Sept.' E. E. Maire *sine num.*," in the Edinburgh Herbarium has been seen. Bonati originally stated: "Plant closely allied to *P. nigra,* Vaniot, which grows in the same region. It differs from it by its middle and lower leaves being petiolate; by its dentate calyx lobes, by its glabrous staminal filaments, etc." The calyx-teeth of *P. nigra* are slightly pinnatifid, as described by Bonati in his original description, but which he confused in his keys presented later, and treated *P. nigra* as with entire calyx-teeth. The filaments of *P. nigra* are sparsely hairy. In the petiolate-leaved specimens from Yunnan, apparently attributable to Bonati's *P. tongtchouanensis*, the filaments are also sparsely hairy. In all respects the Yunnan plants are not sufficiently marked to be separated from the Kweichow plants specifically.

Grassy slopes at altitudes of 2100 to 2300 meters in southern to eastern Yunnan and Kweichow. Flowers violet-red. Flowering from July to October.

YUNNAN: Mengtze, *Henry* 9707 (NYBG), 9707 A (MBG, USNH); Tong-Tchouan, *Maire* s.n. (RBGE); Hai yen sse, *Schoch* 334 (USNH); Mienning, Hsiaokuanshan, *Yü* 17782 (AA).

KWEICHOW: no precise locality, *Maire* s.n. (ANSP, NTU, UCLA); Pin-fa, *Bodinier* 2336 (UCLA); Ko-tchang-keou, *Esquirol* 200 (ANSP, NTU, UCLA); Cheng-matchiang, *Esqirol* 672 (ANSP, UCLA); Chengfeng, *Tsiang* 4263 (NYBG); Kwangcheng, Kupa, *Tsiang* 8631 (NYBG).

A glabrous plant with linear-lanceolate to linear-oblong leaves frequently finely crenulate on the margins. The leaves are mostly alternate, sometimes alternate and opposite or subopposite, frequently sessile but sometimes the lower ones petiolate, especially among the plants from Yunnan. Besides the characters of the leaves, *P. nigra* differs from *P. resupinata* in having larger flowers, glabrous calyx with slightly dentate calyx-teeth, and all the filaments sparsely hairy throughout.

There is some confusion with regard to the authorship of this species. The plant was originally named *P. nigra* Vaniot as shown by a photograph of the type in the Gray Herbarium. Bonati published the description of the species under the name "*P. colletti* Prain var. *nigra* Vaniot" but mentioned "*P. nigra* Vaniot" in the text. Subsequently he again mentioned "*P. nigra* Vaniot" in his notes concerning *P. tongtchouanensis* Bonati (in Notes Bot. Gard. Edinb., 13: 129, 1921) and also on the following page in the key to the species of the series Racemosae. Limpricht and Handel-Mazzetti credited the specific combination to Bonati as the author of "*P. nigra* (Vaniot) Bonati" with "*P. colletti* Prain var. *nigra* Vaniot," as its synonym; but surely the specific name must rather be credited to Vaniot. Incidentally, *P. nigra* Vaniot has been overlooked by the Index Kewensis supplements.

SECTION XIV. LASIOGLOSSA

Erect, usually tall plants; stems usually single; leaves radical or cauline, the cauline sessile to subsessile, shallowly pinnatifid, rarely pinnatisect; inflorescences usually elongated, compact or interrupted, the flowers very short-pedicellate; calyx cleft or not anteriorly, not reticulate or slightly reticulate distally, 5-dentate, the teeth equal to subequal, entire to serrate; corolla-tube erect or slightly bending; galea with long dense hairs on the lower margins, sometimes also on the external surface especially on the dorsal side, the apex either obtuse, acute, edentate or dentate, or short and long-beaked; lower lip shallowly to deeply 3-lobed.

This is a very natural group with consistent floral as well as vegetative characters. In all species, the margins of the galea are provided with dense long multicellular hairs. The cauline leaves are all sessile or subsessile, and in most cases shallowly lobed, rarely pinnatisect. The stems are usually simple with a long terminal inflorescence of subsessile to short-pedicelled flowers. The range of this section extends from Europe to northern Asia and eastward to Japan, but the majority of the species are found in the Himalayas and western China.

Series 43. Gloriosae

Gloriosae Prain, in Ann. Bot. Gard. Calcutta, 3: 92, 1890.

Tall, erect, glabrous or hairy; the stem usually branching at base, simple or rarely branching above; leaves radical or cauline, alternate, petiolate to sessile, pinnatifid to pinnatisect, the lobes usually broad, ovate, rarely lanceolate; inflorescences of long terminal spikes; bracts usually dilate at base; flowers large, 3.5-4.5 cm. long; calyx 5-dentate, the teeth equal to subequal, deltoid to ovate, entire to slightly serrate or dentate; corolla purple or yellow, hairy or glabrous externally, the tube erect, 2-3 times as long as the calyx, the galea more or less erect, villose along the lower margins, the apex rounded, obtuse or acute, edentate, the lower lip about equalling the galea in length, shallowly 3-lobed; staminal filaments all glabrous or 2 of them hairy.

About 7 species from Europe to northern Asia and Japan. Three or four species in China, from northwestern Yunnan to Sikang, northern China, Mongolia and Manchuria (Map 23).

Limpricht combined Prain's Gloriosae and Grandiflorae into one series. This series is characterized by the presence of large flowers with edentate corolla frequently densely villose on the lower margin of the galea. *P. tsekouensis* originally placed here, is rather remotely related to the other species of the series and needs segregation. *P. odontochila* is not known to me and may also be of some other group. *P. bietti* appears to be more properly referred to the Hirsutae.

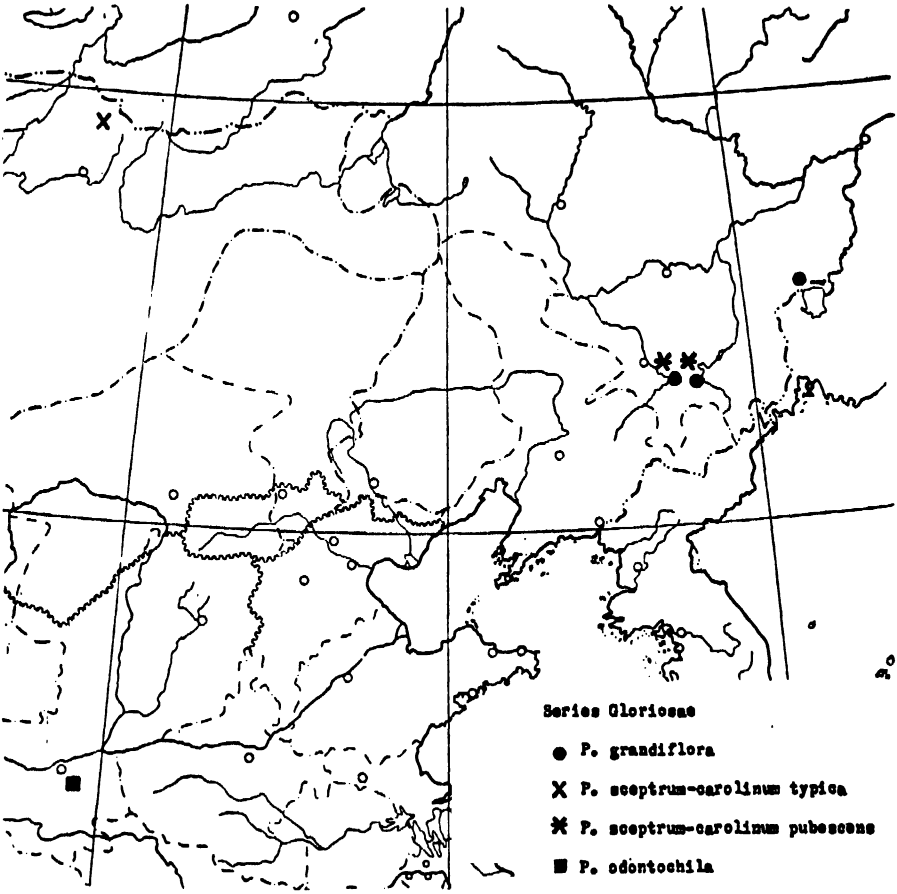
Key to the Chinese Species

A. Plant wholly glabrous, the stem branching above; leaves finely bipinnatisect, the segments lanceolate; galea acute at the apex. .... 153. *P. grandiflora*

AA. Plants usually pubescent, sometimes glabrous, the stem usually branching at base, not branching above; leaves pinnatifid, the segments broad, lobulate to serrate; galea rounded to obtuse at the apex.

  B. Plant with long-petiolate radical leaves and sessile to subsessile cauline leaves; calyx more or less equally 5-dentate, the teeth deltoid-ovate, serrulate; corolla glabrous except the lower margins of the galea; middle lobe of the lower corolla-lip without two teeth at the base.
  154. *P. sceptrum-carolinum*

  BB. Plant with sessile cauline leaves only; calyx equally 5-dentate, the teeth often entire; corolla pubescent throughout; middle lobe of the lower corolla-lip with two teeth at the base. .... 155. *P. odontochila*


Series Gloriosae
● P. grandiflora
X P. sceptrum-carolinum typica
✱ P. sceptrum-carolinum pubescens
■ P. odontochila

Map 23.—Distribution of the series Gloriosae.

153. Pedicularis grandiflora Fischer Plate 4, fig. 123.

Pedicularis grandiflora Fisch., in Mem. Soc. Nat. Mosc., 3: 60, 1812; Maxim., in Bull. Acad. St. Péterab., 24: 85, 1878; 32: fig. 162, 1888; in Mél. Biol., 10: 128, 1878; 12: fig. 162, 1888; Komarov, in Act. Hort. Petrop., 25: 453, 1907; Limpricht, in Repert. Sp. Nov., 20: 199, 1924; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 125, 212, 1934. Fischer's type was from Siberia: " . . . dont nous ignorans la patrie [Dans la collection, dont Mr. de Treskine, Gouverneur d'Irkoutzk, a fait cadeau à la société]."

From Dahuria to northern Manchuria. Flowers purple. Flowering in August.

Manchuria: Kirin, O-mu Hsien, Kushantun, *Kung* 2181 (NYBG); Lake Hanka; *Bohnhof* 268 (ANSP, NYBG); Kirin, *F. H. Chen* 352 (GH, NYBG).

A tall, wholly glabrous plant with the stem branching above. The leaves are bipinnatisect with lanceolate segments cartilaginously dentate on the margins. The galea is falcate and villose on the lower margins. The filaments are glabrous except toward the bases where they are villose. It is related to *P. sceptrum-carolinum* in the general floral structures while differing considerably in habit. *P. sceptrum-carolinum* has a rosette of radical leaves which are long-petiolate, oblong-lanceolate, broadly pinnatifid to pinnatisect. The stem is unbranched above. Prain made *P. grandiflora* into a separate series Grandiflorae (in Ann. Bot. Gard. Calcutta, 3: 93, 1890) while Limpricht combined it with the series Gloriosae (in Repert. Sp. Nov., 20: 199, 1924). As the floral characters of the two species approximate each other closely Limpricht's course is here followed.

154. Pedicularis sceptrum-carolinum Linnaeus

This widely distributed species of northern Eurasia extends from northern and middle Europe to the Pacific coast of Siberia. Bunge recognized two varieties, the typical form, var. *glabra* Bunge, occupying the main area of the range of the species from Europe to Asia, while a pubescent form, var. *pubescens* Bunge, occurs along the eastern edge of the range of the species in the Amur region, northern Manchuria and Korea. The two can be differentiated reliably only on the presence or absence of pubescence.

Key to the Varieties

A. Stem and leaves glabrate. .... 154a. *P. s. typica*
AA. Stem and leaves shortly canescent-pubescent. .... 154b. *P. s. pubescens*

154a. Pedicularis sceptrum-carolinum typica Plate 4, fig. 124.

Pedicularis sceptrum-carolinum α *glabra* Bunge, in Ledeb., Fl. Ross., 3: 302, 1947-49. Bunge considered the typical form of the series as α *glabra*. He cited numerous collections from various parts of Russia and Siberia with the exception of a few assigned to β *pubescens*.

Pedicularis sceptrum-carolinum L., Sp. Pl., 608, 1753; Maxim., in Bull. Acad. St. Pétersb., 24: 84, 1878; in Mél. Biol., 10: 126, 1878; Komarov, in Act. Hort. Petrop., 25: 452, 1907; Limpricht, in Repert. Sp. Nov., 20: 199, 1924. Linnaeus' types: "Habitat in Suecia, Borussiae, Rutheni spongiosis, sylvaticis, riguis." Maximowicz considered the European species as also occurring in Siberia, Kamchatka, Manchuria, northern Mongolia, and Japan, but remarked: "Planta Asiae orientalis fere omnis pertinet ad var. β *pubescentem* Bge., japonica segmentis foliorum solito acutioribus acutiusque fissis et dentatis non nihil discrepat." The Japanese plant was subsequently (in Bull. Acad. St. Pétersb., 32: 615, 1888; in Mél. Biol., 10: 913, 1888) identified by him as *P. gloriosa* Bisset & Moore.

Widely distributed from Europe to Siberia and northern Mongolia. Flowers yellow.

MONGOLIA: Montes Kentei, *Ikonnikov-Galitzky* 167 (UC).

154b. Pedicularis sceptrum-carolinum pubescens Bunge

Pedicularis sceptrum-carolinum β *pubescens* Bunge, in Ledeb. Fl. Ross., 3: 303, 1947-49. Bunge cited for this variety: ". . . β. in Sibirica baikalensi! ad fl. Irkut (Turcz.), inque Davuria! (Turcz., Kulibin *pl. exs.*)."

Pedicularis pubescens Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 125, fig. 7, 217, 1934. Pai based his species on Bunge's variety which he cited in synonymy as

"P. Sceptrum-Carolinum β pubescens Bunge ex Komarov, Fl. Mands, in Act. Hort. Petrop. III. bis. 453. 1907." This is merely a determination by Komarov for plants of the Amur region, Kirin, and Korea, while Bunge's variety was originally published much earlier as cited above. Pai cited the following specimens: *H. W. Kung* 1686, 1854, 1962, and *H. F. Chen* 591, all from Kirin.

At altitudes of about 400 to 500 meters in northern Manchuria, eastern Siberia, and Korea. Flowers yellow.

MANCHURIA: Kirin, *H. F. Chen* 591 (GH, NYBG).

155. **Pedicularis odontochila** Diels

Pedicularis odontochila Diels, in Bot. Jahrb., 36, Beibl. 82: 97, 1905; Limpricht, in Repert. Sp. Nov., 20: 199, 1924. Diels' type was from Shensi: "*N.* [Nord-District] Huan tou shan—blüh im Juli (Gi[raldi] 7095)."

It has not been seen. Limpricht cited the same specimen as "Schenhsi, Tsin ling schan, Berg Kwan tou schan (Giraldi, n. 7095)."

In Shensi. Known from the original collection only. No specimen seen.

Diels noted: "Diese Art steht in der Ser. *Sceptra* durch die beiden Zähne auf der Lippe allein und ist sofort daran zu erkennen. Auch die Behaarung der Korolle teilt sie nur mit *P. grandiflora* Fisch., welche schon habituell vollig obweicht." Limpricht included the species in the series Gloriosae but remarked: "Vielleicht nur eine Form von *P. striata* Pall."

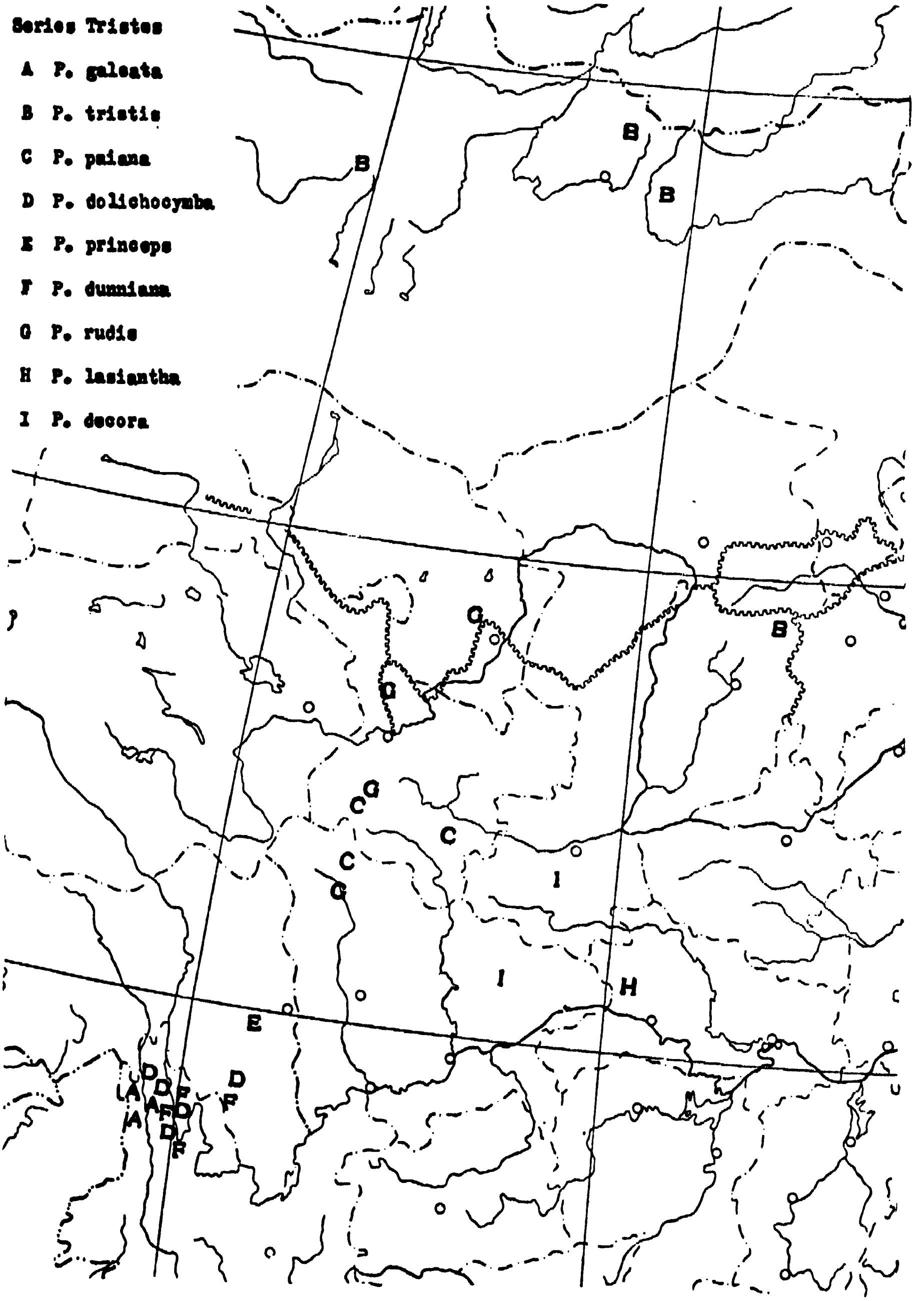
Series 44. Tristes

Tristes Benth., in DC. Prodr., 10: 579, 1846.

Tall, erect plants, the roots single, somewhat fleshy, with a tuft of fibrous roots near the top; stems simple, usually somewhat hairy; leaves cauline, alternate, sessile, ovate to oblong-linear, shallowly to deeply pinnatifid to pinnatisect, the lobes serrate to dentate; inflorescences terminal, usually elongated, compact or interrupted; bracts foliaceous, large or small; pedicels very short; calyx short-cylindric, hairy or glabrous (pubescence often glandular), usually not reticulate or very slightly so distally, 5-dentate, the teeth equal to subequal, deltoid to oblong, entire to serrate; corolla yellow or purple, the tube about as long as the calyx to twice as long, glabrous or sometimes hairy, the galea usually bending, obtuse to pointed at apex, either pointing downward or forward, usually densely hairy on the ventral margins, hairy or rarely glabrous dorsally on the outside, the lower lip slightly shorter or as long as the galea, 3-lobed, the lobes equal to subequal, rounded, usually ciliate on the margins; stamens inserted near the middle of the tube, all 4 filaments glabrous; styles included or the stigmas exserted.

About 10 species from southern Tibet and western China to eastern Siberia (Map 24).

The scope of the series Tristes has been considerably enlarged by later authors and has been variously delimited. Bonati's keys (in Bull. Soc. Bot. France, 57: Mem. 18: 24, 1910; in Notes Bot. Gard. Edinb., 13: 131, 1921), included a number of species that clearly are not of this series. Earlier, Prain (in Ann. Bot. Gard. Calcutta, 3: 81-83, 1890) attempted to split the group into a number of smaller series. His assignment of *P. lachnoglossa*



Map 24.—Distribution of the series Tristes.

and *P. recurva* to the series Lachnoglossae and Proboscideae respectively was very reasonable. Not only do these species have different floral structures but they also have different root systems. The species of the series Tristes proper all have a strong simple tap root with a cluster of fibrous roots near the top. In *P. lachnoglossa* the root system consists of a single very fleshy root oftentimes branching above, forming several heads. In *P. recurva* the root system consists of a cluster of slightly fleshy roots.

However, the inclusion of the species *P. compacta* Steph. with *P. recurva* by Prain in the series Proboscideae is not appropriate. The wide difference between these two species makes this hardly comprehensible. Nor does the division of the two series Tristes and Rudes of Prain seem satisfactory. On the other hand, the inclusion of the species *P. pteridifolia* by Bonati in the series Tristes is also unsatisfactory. With the removal of these various species the rest form a fairly natural and homogeneous group by themselves.

The species thus remaining in the group consist of both beaked and beakless ones. While their close kinship is clearly evident, nevertheless it seems desirable to treat them as forming two series. Not only can the presence or absence of the beak be conveniently used in classification, but also the two groups exhibit certain other differences. The beakless group shows a tendency of the galea to change from its erect position to that of curved, and for the apex of the galea to change from obtuse to pointed. In the beaked group the curved galea is fixed and remains in this position, while the pointed apex has become a distinct beak. Furthermore, the leaves of the beakless group are usually broad, from ovate to oblong-linear, while those of the beaked group are always narrow, from oblong-lanceolate to linear-lanceolate. Hence the beakless group here retains the name Tristes but with a narrower definition, while the beaked group is segregated to form the series Craspedotrichae, Lasiophrydes, and Trichoglossae.

Key to the Chinese Species

A. Galea not boat-shaped, rounded and closed in front, with the apex pointing downward, erect and straight below bending distally only, with or without dense hairs along the lower margins.

  B. Calyx sparsely pubescent, the teeth obtuse, densely serrate; corolla purple; galea with glabrous margins; lower lip of the corolla ciliate along the margins; anther-cells acute at base. .... 156. *P. galeata*

  BB. Calyx densely pubescent, the teeth acute, entire or serrate; corolla yellow; galea with the margins densely hairy; lower lip of the corolla glabrous along the margins; anther-cells with bases obtuse.

    C. Corolla 26-30 mm. long, the galea 4-5 mm. wide; calyx-teeth entire or obscurely serrate; filaments glabrous. .... 157. *P. tristis*

    CC. Corolla 40-45 mm. long, the galea 6-8 mm. wide; calyx-teeth distinctly serrate; filaments sparsely hairy. .... 158. *P. paiana*

AA. Galea boat-shaped, with the apex pointing outward and open in front, usually strongly bending at base, and horizontal, rarely erect, always with dense hairs along the lower margins.

B. Leaves ovate-oblong to oblong-lanceolate, about 3-3.5 times as long as wide, shallowly pectinately lobed; corolla deep rose to blackish purple, the tube to 1½ times as long as the calyx; lower lip narrow, much shorter than the galea; stigma conspicuously long-exserted. .... 159. *P. dolichocymba*

BB. Leaves linear to rarely oblong-lanceolate, 4 or more times as long as wide, deeply pinnatifid; corolla yellow, strongly bent below, horizontal and close to the lower-lip; corolla-tube 2-3 times as long as the calyx; lower lip about as long as the calyx; stigma included or very shortly exserted.

  C. Tube of corolla glabrous externally; calyx glabrous or sparsely pubescent, not glandular; galea with apex subacute.

    D. Calyx glabrous, not reticulate, the teeth deltoid, subentire. 160. *P. princeps*

    DD. Calyx slightly pubescent, slightly reticulate, the teeth linear, entire to obscurely denticulate. .... 161. *P. dunniana*

  CC. Tube of corolla hairy externally; calyx glandular-hairy; galea with apex more or less obtuse.

    D. Calyx-teeth oblong, obtuse, deeply serrate; stigma usually included. .... 162. *P. rudis*

    DD. Calyx-teeth linear-triangular, acute, entire to obscurely denticulate; stigma usually short-exserted.

      E. Stem shortly branched above; corolla-tube about twice as long as the calyx; galea broad, to 6 mm. wide. 163. *P. lasiantha*

      EE. Stem simple throughout; corolla-tube about thrice as long as the calyx; galea narrower, to 4.5 mm. wide. 164. *P. decora*

156. Pedicularis galeata Bonati Plate 5, fig. 125.

Pedicularis galeata Bonati, in Notes Bot. Gard. Edinb., 13: 130, 1921; 17: 89, 1929; Limpricht, in Repert. Sp. Nov., 20: 228, 1924; Hand.-Maz., Symb. Sin., 7: 855, 1936. The type was from "'West China:—Mekong-Salween divide, Yunnan. On open, stony pasture on ledge of cliffs. Lat. 28° 12′ N. Alt. 14,000 ft. Plant of 7-12 ins. Flowers, base yellowish, apex and beak deep black-crimson. August 1917.' G. Forrest. No. 14,697." Two duplicates studied by Bonati are in the Bonati Herbarium, whence they pass to the Academy of Natural Sciences of Philadelphia and the University of California at Los Angeles.

Alpine meadows at altitudes of about 4000-4270 meters, in northwestern Yunnan. Flowers purple. Flowering from June to August.

YUNNAN: Mekong-Salween divide, *Forrest* 14697 (ANSP, UCLA); Mekong-Salween divide, mountains of Nakela east of Yuragan, *Rock* 23113 (CM, MBG, NYBG, UC, UP, USNH), 23436 (NYBG, UC, UP, USNH); between Salween and Irrawadi, above Champutong and Lake Tsukue, *Handel-Mazzetti* 9921 (GH, USNH); Upper Kiukiang Valley (Clulung), Tsugum, *Yü* 19886 (AA); Chawchi Pass, *Farrer* 1880 (RBGE).

In the shape of the galea, which is closed in front instead of boat-shaped and open in front, this is like *P. tristis*. But it differs from the latter species in the shape and size of the leaves, in the slightly hairy calyx with deeply incised teeth, in the slightly hairy galea with glabrous margins, and in the more acute anther-cells. The vegetative characters of *P. galeata* suggest close relationship with *P. dolichocymba* from which it differs in broader and shorter leaves, shape and glabrous margins of the galea and smaller anthers.

157. Pedicularis tristis Linnaeus Plate 5, fig. 126.

Pedicularis tristis L., Sp. Pl., 608, 1753; Maxim., in Bull. Acad. St. Pétersb., 32: 567, fig. 65, 1888; in Mél. Biol., 12: 844, fig. 65, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 218, 1890; Limpricht, in Repert. Sp. Nov., 20: 227, 1924; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 223, 1934. Linnaeus' type: "Habitat in Sibiria."

Mountain slopes and alpine meadows at altitudes of 2750 to 3050 meters, from Siberia to northern Mongolia and northern Shansi. Flowers yellow. Flowering in July.

MONGOLIA: ad limites Mongol. chin. pr. Mondae, *Turczaninow* s.n. (ANSP, UCLA); northern Mongolia and Khangai, *Ikonnikov-Galitzky* 219 (NYBG); Montes Kentei orientales ad fontes fluviorum Kerulen et Onon, *Ikonnikov-Galitzky* 109 (UC), 161 (UC); Montes Kentei ad fontes fluviorum Tola, Mensa, et Iro, *Ikonnikov-Galitzky* 2894 (UC), 3104 (UC).

SHANSI: Mt. Wutai, *Tang* 1124 (NYBG).

Maximowicz mentioned that the Siberian plants have the calyx-teeth entire while the Chinese plants have serrate teeth. However, the Chinese plants agree closely with the Siberian plants in having the calyx-teeth mostly entire to sometimes obscurely serrate. They are never so distinctly serrate as depicted in Maximowicz's drawing.

158. Pedicularis paiana nom. nov. Plate 5, fig. 127.

Pedicularis tristis L. var. *macrantha* Maxim., in Bull. Acad. St. Pétersb., 32: 567, 1888; in Mél. Biol., 12: 844, 1888; Bonati, in Bull. Soc. Bot. France, 55: 311, 1908; Limpricht, in Repert. Sp. Nov., 20: 228, 1924; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 34, 1933; Pai in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 223, 1934. Maximowicz's type, "Prov. Sze-tschuan septentrionali: trajectu montano Guma-kika (Potanin, 1885)," has not been seen.

Plant to 3.5 dm. tall; rhizome and root straight, simple, with a tuft of fibrous rootlets on the rhizome; stems simple, erect, pubescent, leafy. Leaves mostly cauline, few basal, alternate, sessile to subsessile, oblong to oblong-lanceolate, to 8 cm. long and 2 cm. wide, sparsely pubescent on both sides, pinnatifid, the apex obtuse, the base narrowed or broadened, the segments 10 to 15 on each side, cut to about midway from the margins to the midrib, to 5-6 mm. wide, obtuse to rounded, the base broad, the margins dentate. Inflorescences long, terminal, spicate, the flowers sessile to subsessile, more or less distant, the bracts foliaceous, longer than the calyx, ovate-oblong, pinnatifid. Calyx pubescent externally, membranaceous, the tube about 0.8-1.5 cm. long, slightly reticulate, the teeth 5, subequal, acute, more or less distinctly serrate. Corolla yellow, 40-45 mm. long, more or less puberulous externally throughout, the tube erect, about twice as long as the calyx, the galea about as long as the tube, straight and erect proximally, falcate distally, about 6-8 mm. wide, ending in an acute apex, densely ciliate on the margins, the lower lip as long as the galea or slightly shorter, 3-lobed, the lobes subequal, rounded, the median one scarcely distad. Stamens inserted near the base of the tube, the filaments sparsely hairy. Stigmas included or slightly exserted. Capsules unknown.

Alpine meadows at an altitude of about 2900 meters, from western Szechuan to northwestern and central Kansu. Flowers yellow. Flowering in July.

KANSU: central Kansu, Lien-hoa-shan, *Rock* 12702 (ANSP, GH, NYBG, USNH); southwestern Kansu, T'ao River basin, Hsiaku, east of Adjuan, *Rock* 12637 (ANSP, NYBG).

This species is related to *P. tristis,* differing in the decidedly larger flowers, distinctly serrate calyx-teeth, and sparsely hairy filaments. It occurs in northern Szechuan where the type was collected, and in adjacent parts of Kansu; this is geographically distinct from the range of *P. tristis,* which occurs to the north and northwest.

This species is named in honor of Dr. Y. Y. Pai, who has made important contributions to the study of the genus *Pedicularis* in China. The specifiic name " *macrantha* " is preoccupied.

159. Pedicularis dolichocymba Handel-Mazzetti Plate 5, fig. 128.

Pedicularis dolichocymba Hand.-Maz., in Anz. Akad. Wiss. Wien Math. Nat. Kl., 57: 102, 1920; Symb. Sin., 7: 855, fig. 25, 5 & 6, 1936; Limpricht, in Repert. Sp. Nov., 20: 228, 1924; 23: 335, 1927; Bonati, in Notes Bot. Gard. Edinb., 15: 156, 1926; 17: 80, 1929. The type was from: "Prov. Yunnan bor.-occid.: In caespitosis ad limitem silvarum in summitate sita juxta jugum Niutschang supra vicum Bödö inter oppida Lidjiang (Likiang) et Dschungdien, 4200 *m.,* leg. 7. VIII. 1914." An isotype, from the Bonati Herbarium, passes to the Academy of Natural Sciences of Philadelphia. This number, according to a later redescription of the species by the author (l.c. 1936), is *Handel-Mazzetti* 4543.

Pedicularis tristiformis Bonati, Genre Pedicul., 70: 73, 1918, *in obs. nomen.* Bonati mentioned only (l.c. 73) " De la Chine occidentale." In 1921 (in Notes Bot. Gard. Edinb., 13: 104, 1921) he noted: ". . . . His [Handel-Mazzetti's] *P. dolichocymba* is my *P. tristiformis,* collected by Captain Kingdon Ward on the Chungtien Plateau as long ago as 1912, but which I had never been able to publish."

Pedicularis macrocalyx Bonati, in Notes Bot. Gard. Edinb., 15: 156, 1926; Limpricht, in Repert. Sp. Nov., 23: 335, 1927. Bonati's type was from "Yunnan: Eastern slopes of Mount Dyinaloko, northern peak of the Likiang Snow Range. 13,500 ft. Flowers purple, in Abies forest. Aug. 1923.' J. F. Rock No. 10420." Isotypes are in the herbaria of the Academy of Natural Sciences of Philadelphia and the University of California. They prove, together with the description, that this species is exactly identical with *P. dolichocymba,* and accordingly this is reduced into the synonymy of the latter.

Open, alpine meadows or rocky slopes and among boulders, at altitudes of 3500 to 4200 meters in northwestern Yunnan and southern Sikang. Flowers deep rose to blackish purple. Flowering in August.

SIKANG: mountains southeast of Mu-li, *Forrest* 22148 (UC, USNH); Glacier Lake, *Ward* 4666 (RBGE).

YUNNAN: Niutschang, above Bödö, Dschungdien, *Handel-Mazzetti* 4543 (ANSP); mountains in the northeast of the Yangtze bend, *Forrest* 10801 (ANSP, UC); Mekong-Yangtze divide, *Forrest* 13139 (ANSP, UCLA); Mekong-Salween divide, *Forrest* 14579 (ANSP, UCLA); Young-ning, *Forrest* 20500 (ANSP, UCLA); Chungtien, *Schneider* 2385 (UCLA, USNH); between Likiang, Tungshan, Tuinaoko and Tsilikiang, Yangtze drainage basin, *Rock* 9763 (ANSP, GH, NYBG, UC, USNH); eastern slopes of Likiang Snow Range, Yangtze watershed, *Rock* 10420 (ANSP, UC); Chungtien, Juatze, *Yü* 13644 (AA); A-tun-tze, *C. W. Wang* 60913 (AA); Wei-si District, Yeh-chih, *C. W. Wang* 68648 (AA); northern flank of Haba Snow Range, *Feng* 2144 (AA); no precise locality, *Yü* 2682 (AA).

This distinct species is well characterized by its tall erect habit with simple angular sparsely hairy stems and chartaceous, oblong-lanceolate, shallowly pectinately lobed leaves. It becomes very blackened in the dry state. The flower is rather large with a boat-shaped galea sparsely ciliate externally and densely so along the lower edges.

160. Pedicularis princeps Bureau & Franchet Plate 5, fig. 129.

Pedicularis princeps Bur. & Franch. ex Franch., in Morot, Journ. de Bot., 5: 129, 1891; Bonati, in Bull. Herb. Boiss., II, 7: 544, 1907; in Bull. Soc. Bot. France, 54: 186, 1907; Limpricht, in Repert. Sp. Nov., 20: 228, 1924; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 216, 1934. The type, "Chine, Province de Se-tchuen, entre Ta-tsien-lou et la frontière du Yun-nan [recueillie pendant le voyage de M. Bonvalot et du Prince Henri d'Orléans en 1890]," has not been seen.

In Sikang.

SIKANG: Ta-tsien-lou, *Soulié* 858 (UCLA).

This species is related to *P. dolichocymba* in the shape of the galea, hairiness of the corolla and the structure of the lower corolla-lip. However, it is a much taller plant with smaller flowers, subentire calyx-teeth, longer corolla-tube and bending instead of erect galea. In the tall habit and the general shape and structure of the corolla it resembles *P. dunniana* (*P. aequibarbis* Hand.-Maz.) but differs in the shortly petiolate leaves, shortly pedicellate flowers, glabrous calyx with deltoid teeth, more hairy galea, and broader lower lip.

161. Pedicularis dunniana Bonati Plate 5, fig. 130.

Pedicularis dunniana Bonati, in Notes Bot. Gard. Edinb., 8: 44, 1913; Limpricht, in Repert. Sp. Nov., 20: 228, 1924. The type was from northwestern Yunnan: "Plant of 2-4 ft. Flowers pale yellow. Dry, shady situations in pine forests on the divide between the Lichiang and Hoching valleys. Lat. 26° 50′ N. Alt. 8000-10,000 ft. October 1910.' F. Forrest, No. 7389." Isotypes are in the Bonati Herbarium.

Pedicularis aequibarbis Hand.-Maz., in Anz. Akad. Wiss. Wien Math. Nat. Kl., 57: 103, 1920; Symb. Sin., 7: 856, pl. 15, fig. 5, 1936; Limpricht, in Repert. Sp. Nov., 20: 228, 1924; 23: 335, 1927; Bonati, in Notes Bot. Gard. Edinb., 15: 157, 1926. Handel-Mazzetti's type was from northwestern Yunnan: "Eiusdem ditionis [Prov. Yünnan bor.-occid.] in silvis abietinis montis Piepun prope Dschungdien, 3600 *m.* legi 12 VIII. 1914." An isotype is in the Bonati Herbarium. This type collection, according to Handel-Mazzetti's later redescription of the species (l.c. 1936) is *Handel-Mazzetti* 4796. The specimen available, together with the descriptions and illustrations, undoubtedly show that the species is conspecific with *P. dunniana*. The only difference Handel-Mazzetti could make out between the two is that in *P. dunniana* the filaments are, as Bonati described, all glabrous; while in *P. aequibarbis* the anterior filaments are hairy at the base. In examining type specimens of both species, the anterior filaments are found, in either case, to be very sparsely hairy near the base to nearly glabrous, which evidently denotes that this is not a constant character.

Alpine meadows and dry, shady situations in conifer forests at altitudes of about 2440 to 4000 meters, in northwestern Yunnan and Sikang. Flowers pale yellow. Flowering from July to October.

SIKANG: Tatsienlu, *Cunningham* 212 (RBGE).

YUNNAN: Chungtien, *Handel-Mazzetti* 4796 (ANSP), *Forrest* 10604 (UCLA); between the Likiang and Hoching valleys, *Forrest* 7389 (ANSP, UCLA); Gan Haitze, Yangtze watershed, western slopes of Likiang Snow Range, *Rock* 4575 (USNH); Yangtze watershed, eastern slopes of Likiang Snow Range, *Rock* 4859 (ANSP, USNH), 5652 (USNH); Mt. Shwemenkan, between the Chungtien River and the Yangtze, northwest of the Likiang Snow Range, *Rock* 9799 (UC, USNH); Ngu leh keh, prope Likiang, *Schneider* 1829 (USNH); Likiang Snow Range, *Ching* 30395 (AA); northeastern Likiang, Ta-koo on the Yangtze, *Ching* 21210 (AA); Chungtien, Haba, *Yü* 13550 (AA); Muli, Kulu, Hsiyehtze, *Yü* 14346 (AA); no precise locality, *Forrest* 28818 (ANSP).

The plant is very tall like *P. princeps* which it closely resembles in the strongly bent boat-shaped galea. The galea of *P. dunniana* is, however, more densely hairy. The calyx also differs in being hairy with more or less linear instead of deltoid teeth.

162. **Pedicularis rudis** Maximowicz Plate 6, fig. 131.

Pedicularis rudis Maxim., in Bull. Acad. St. Pétersb., 24: 67, 1878; 32: 568, fig. 67, 1888; in Mél. Biol., 10: 102, 1888; 12: 845, fig. 67, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 215, 1890; Diels, in Bot. Jahrb., 29: 572, 1900; Limpricht, in Repert. Sp. Nov., 20: 228, 1924; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 34, 1933; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 219, 1934; Hand.-Maz., Symb. Sin., 7: 857, 1936; Walker, in Contr. U. S. Nat. Herb., 28: 659, 1941. The types were from Inner Mongolia and Kansu: "In *Mongolia* australis jugo Alaschan in faucibus sylvestribus frequens, in *Chinae* prov. Kansu in vallibus et fruticetis frequens, prope templum Tschöbsen non procul a lacu Kuku-nor, in collibus rara (Przewalski)." The first locality is now in Ninghsia Province. A duplicate of that number is in the Bonati Herbarium (ex Herb. Hort. Bot. Petrop.) bearing the label "Pedicularis rudis Maxim. Mongolia, Montes Alaschan, 30 VI 1873, No. 186. Legit N. M. Przewalski. Det. Maximowicz," in Maximowicz's handwriting; it passes to Academy of Natural Sciences of Philadelphia.

Grassy slopes and spruce forests at altitudes of 2350 to 3350 meters, in Ninghsia, Kansu, Shensi, northeastern Chinghai and northeastern Szechuan. Flowers yellow. Flowering from June to August.

NINGHSAI: Alashan, *Przewalski* 186 (ANSP).

KANSU: southwestern Kansu, T'ao River basin, near Choni, *Rock* 12868 (ANSP, GH, USNH); upper Tebbu country, *Rock* 13104 (ANSP, GH, USNH); near Pingfan, *Ching* 568 (USNH).

SZECHUAN: Sungpan District, *Fang* 4295 (ANSP, GH, NYBG, USNH).

Fang 4295 is in fruit, and agrees well with other plants and with the description of the fruits given by Maximowicz (l.c., 1888) except that when fully mature these reach 1.2 cm. long.

In the shape and the structure of the corolla and especially of the galea this species is evidently closest to *P. princeps* and *P. dunniana*, but may be readily distinguished by the glandular-pubescent calyx and the distinctly serrate calyx-teeth.

163. **Pedicularis lasiantha** sp. nov. Plate 6, fig. 132.

Planta elata, 7 dm. vel ultra alta; caulibus singulis, erectis, foliatis, sparse pubescentibus, supra sparse breviter ramosis, ramis vix 16 cm. longis; foliis sparsis, sessilibus, lineari-lanceolatis vel lanceolatis, 7-15 cm. longis, 2.2-4.3 cm. latis, utrinque parcissime pubescentibus vel glabris, apice subobtusis, basi late truncatis, pinnatifidis (ex margine ¾ ad costam incisis), lobis circiter 20-jugis, oblongis, obtusis, duplicato-serratis; inflorescentiis longe sub-spicatis terminalibus, interruptis; bracteis foliaceis flores superantibus, lanceolatis, pinnatifidis vel serratis; pedicellis vix 1.5 mm. longis;

calyce campanulato, circiter 6 mm. longo, glanduloso, pubescente, supra leviter reticulato, 5-dentato, dentibus subaequalibus, oblongo-deltoideis, acutis, integris; corollā luteā (?), circiter 2.2 cm. longā: tubo recto, circiter 1.2 cm. longo, externe pubescente; galeā basi profunde curvatā, horizontali, valde dilatatā, naviculari, antice apertā subtruncatā, circiter 1.2 cm. longā 6 mm. latā, margine praecipue villosā; labio inferiore galeam aequante, 3-lobata, lobis rotundatis, margine fimbriato-ciliatis, lobo medio majore; filamentis glabris, antheris oblongis, basi subacutis; stylo vix exserto; capsulis orbicularibus breviter acuminatis, 7 mm. longis, 5 mm. latis, haud compressis, quam calyce disrupto duplo longioribus.

Type, in western Hupeh, collected in flower and fruit, June 1901, by E. H. Wilson, No. 2182 (Veitch & Sons); holotype in the United States National Herbarium; isotype in the herbarium of the New York Botanical Garden.

Western Hupeh. Flowers yellow (?). Flowering in June.

HUPEH: no precise locality, *Henry* 6741 (USNH); western Hupeh, *Wilson* 2182 (NYBG, USNH).

This species is very close to *P. rudis* and *P. decora*. From the former it differs in the narrower and entire calyx-teeth, longer lower lip, more acutely based anther-cells, and smaller fruits; from the latter in the shorter corolla-tube and broader galea.

164. Pedicularis decora Franchet Plate 6, fig. 133.

Pedicularis decora Franch., in Bull. Soc. Bot. France, 47: 28, 1900; Diels, in Bot. Jahrb., 29: 572, 1900; Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922; in Repert. Sp. Nov., 20: 229, 1924. The type was from northwestern Szechuan: "Su-tchuen, autour de Tchen-keou-tin (Farges, n. 719)." A duplicate from the Bonati Herbarium passes to the Academy of Natural Sciences of Philadelphia.

In northeastern Szechuan and southern Shensi (ex Limpricht). Flowers yellow.

SZECHUAN: Tchen-keou-tin, *Farges* 719 (ANSP).

Franchet described the corolla-tube as " tubo gracili 15-18 mm. longo, pilis rufis vestito " and the calyx as " Calyx piloso glandulosus, 15-18 mm. longus," but the figure given for the length of the calyx is evidently an error. The calyx in the type specimen examined is very short, about 5-6 mm. long including the teeth. The corolla-tube, however, is slender and measures 15-18 mm. in length as Franchet described. Thus the corolla-tube is actually 3 times as long as the calyx and in this respect the species differs from the others. Bonati, apparently following Franchet's original description without consulting the type specimen, erred in his key (in Notes Bot. Gard. Edinb., 13: 132, 1921) by characterizing *P. decora* as with " tube of the corolla equalling the calyx."

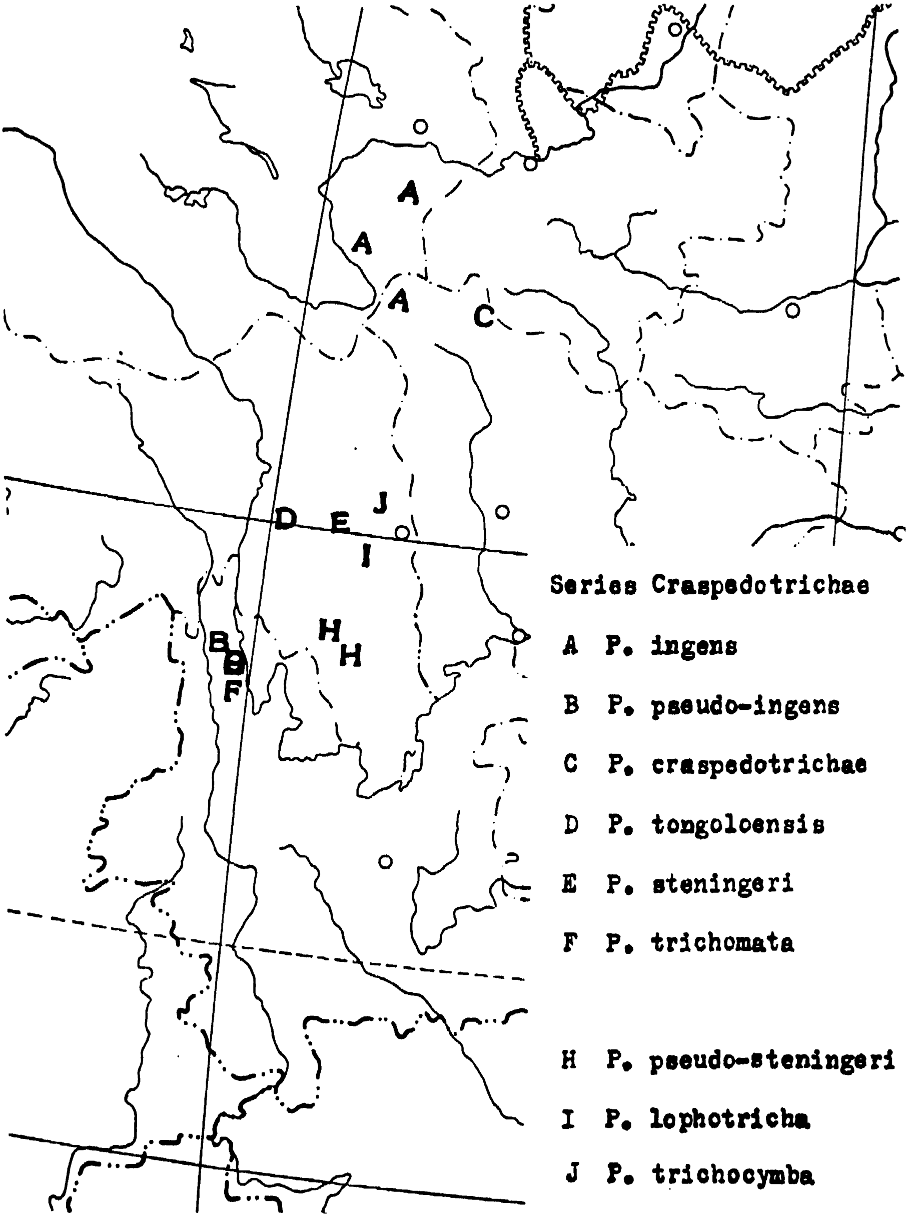
This species is very close to *P. rudis*, having similar leaves, similar glandular pubescence on the calyx and a similarly hairy corolla-tube. It has, however, somewhat smaller leaves and calyces, and lanceolate, acute and obscurely crenulate calyx-teeth instead of broader and distinctly serrate ones as in *P. rudis*. Moreover, the corolla-tube of *P. decora* is more slender, about 3 times as long as the calyx and the anther-cells are acute at the bases, while in *P. rudis* the corolla-tube is twice as long as the calyx and the anther-cells are obtuse at the bases.

Series 45. Craspedotrichae ser. nov.

Tall, erect plants, roots simple, somewhat fleshy, with a tuft of fibrous ones near the top; stems simple, hairy or glabrous; leaves cauline, alternate, more or less dense, rarely cauline and radical, sessile, oblong-linear to oblong-lanceolate, usually shallowly and numerously pinnatifid, rarely to one half the length from the margin to the midrib, the lobes obtuse, serrate or dentate; inflorescences usually elongated, dense or interrupted; bracts foliaceous, longer or shorter than the flowers; pedicels very short; calyx cylindric to ovoid, not cleft anteriorly, not reticulate or very slightly so distally, 5-dentate, the teeth deltoid to ovate-oblong, serrate to subentire; corolla yellow to purple, the tube slightly shorter to twice as long as the calyx, erect, glabrous; galea bending forward, more or less densely long-hairy along the lower margins, glabrous dorsally, the apex produced into a beak, the beak short, straight, and conical, the lower lip shorter than or about as long as the galea, shallowly to deeply 3-lobed, the lobes equal to subequal, rounded to subacute, entire to subdenticulate, glabrous; stamens inserted near the middle of the tube, 2 or rarely 4 filaments hairy; stigma included or exserted.

About 10 species from southwestern and northwestern China to the Altai region (Map 25).

In the beaked species originally included in the series Tristes, but now being separated therefrom, three groups are clearly recognizable. The first group comprises the majority of the species which are characterized by an uncleft calyx with 5 usually serrate teeth, short conical beak, 3-lobed lower lip with the margins often denticulate, and anteriorly hairy filaments. This group is here designated as the series Craspedotrichae. The second group consists of *P. lasiophrys* and *P. cinerascens* and is being named Lasiophrydes. These two species are characterized by a slightly cleft calyx with strictly entire teeth, a long cylindric beak, a 3-parted lower lip with the lobes divided nearly or quite to the base and stipitate, a galea sometimes hairy in front in addition to the hairs on the margins, and the filaments all glabrous. The third group, here made into the series *Trichoglossae*, consists of *P. trichoglossa* and *P. rhodotricha*. These last species are distinguished by the anteriorly cleft calyx with distinctly serrate teeth, the pubescent corolla with hairs on the margins of the galea as well as on the corolla-tube and on the dorsal side of the galea, the strongly curved galea with a long, slender, bending beak, the broad lower lip sometimes ciliate on the margins, and the glabrous filaments.



Map 25.—Distribution of the series Craspedotrichae.

The status of several of the described species of the series Craspedotrichae, for which no material is now accessible, is somewhat dubious. A number of species, apparently closely related to but distinct from those hitherto described, are now being proposed as new. However, until type materials of all species can be examined the specific identities of several of them must remain doubtful, so the present arrangement is tentative.

Key to the Chinese Species

A. Bracts much shorter than the flowers; calyx more or less densely pubescent externally, the teeth distinctly serrulate; galea produced into a very short conical beak. 165. *P. ingens*

AA. Bracts (at least the lower ones) as long as or usually longer than the flowers; calyx usually glabrous or sometimes sparsely hairy, glabrous or hairy on the teeth, the teeth entire or rarely serrulate; galea produced into a distinct but conical beak.

B. Staminal filaments all glabrous.

C. Corolla rose, its tube hardly as long as or only very slightly longer than the calyx. .... 166. *P. craspedotricha*

CC. Corolla yellow, its tube twice as long as the calyx. .. 167. *P. tongolensis*

BB. Two of the staminal filaments or sometimes all 4 of them hairy.

C. Corolla-tube hardly as long as the calyx; 2 of the staminal filaments hairy.

D. Plant tall, to 7.5 dm. tall; leaves 5-7 cm. long; inflorescences 40-50 cm. long; corolla about 25-30 mm. long; calyx-teeth entire. 168. *P. steiningeri*

DD. Plant lower, about 3 dm. tall; leaves 3.5-4.5 cm. long; inflorescences about 7 cm. long; corolla about 20-25 mm. long; calyx-teeth inconspicuously serrate to subentire. .... 169. *P. trichomata*

CC. Corolla-tube 1½ to 2 times as long as the calyx; 2 or all 4 of the staminal filaments hairy.

D. Calyx-teeth ovate-oblong, distinctly serrulate; styles included. 170. *P. pseudo-ingens*

DD. Calyx-teeth deltoid to triangular-oblong, entire or obscurely serrulate; apices of styles very shortly exserted.

E. Calyx larger, about 1.2 cm. long and 5 mm. wide, the teeth ciliate on the margins; corolla larger, to 3 cm. long, the tube about 1½ times as long as the calyx; hairs on the corolla-margins very dense, to 3 mm. long.

F. Serrations of the leaves deeper, about ⅓ to ½ the distance from the margins to the midrib; 2 of the staminal filaments hairy, the posterior ones glabrous. 171. *P. pseudo-steiningeri*

FF. Serrations of the leaves shallower, about ¼ to ⅓ the distance from the margin to the midrib; all 4 staminal filaments hairy, the posterior ones sparsely so distally. 172. *P. lophotricha*

EE. Calyx smaller, to 1 cm. long and 4 mm. wide, the teeth glabrous; corolla smaller, to 2.6 cm. long, the tube twice as long as the calyx; hairs on the corolla-margins less dense, to 1.5 mm. long. .... 173. *P. trichocymba*

165. Pedicularis ingens Maximowicz Plate 6, fig. 134.

Pedicularis ingens Maxim., in Bull. Acad. St. Pétersb., 32: 565, fig. 61, 1888; in Mél. Biol., 12: 841, fig. 61, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 210, 1890; Limpricht, in Repert. Sp. Nov., 20: 230, 1924; Marquand, in Journ. Linn. Soc. Bot., 48: 212, 1929; Mus. Bot. Berol., ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 33, 1933; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 212, 1934. The type, "Prov. Sze-tschuan parte boreali: ad fluv. Nerechu (Potanin, 1885)," has not been seen.

Grassy places and rocky slopes, at altitudes of about 3050 to 3450 meters, in northern Szechuan and eastern Chinghai. Flowers yellow. Flowering in June and July.

CHINGHAI: around Radja, Radja and Yellow River Gorges, *Rock* 14217 (ANSP, GH, NYBG); Senge Kanchak, near H'tsechu, between Labrang and Yellow River, *Rock* 14481 (ANSP, GH, USNH).

Bonati in his key (in Notes Bot. Gard. Edinb., 13: 131, 1921) listed this species under the heading " bracts exceeding the flowers in length," which is erroneous. Maximowicz described the bracts as exceeding the calyx only, and thus much shorter than the flowers, and this is the case as observed in the specimens cited above. Bonati also described the filaments in his key as all hairy, while in reality only the anterior filaments are hairy.

166. **Pedicularis craspedotricha** Maximowicz

Pedicularis craspedotricha Maxim., in Bull. Acad. St. Pétersb., 32: 564, fig. 58, 1888; in Mél. Biol., 12: 839, fig. 58, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 207, 1890; Limpricht, in Repert. Sp. Nov., 20: 230, 1924. The type, "China: Szetschuan boreali, trajectu Gumà-kikà (Potanin, 1885)," has not been seen. According to Limpricht this locality is a pass in the Min Shan, which is along the Kansu border.

In northwestern Szechuan. Known from the original collection only. No specimen seen.

167. **Pedicularis tongolensis** Franchet

Pedicularis tongolensis Franchet, in Bull. Soc. Bot. France, 47: 29, 1900; Bonati, in Bull. Herb. Boiss., II, 7: 544, 1907; Limpricht, in Repert. Sp. Nov., 20: 230, 1924. The types were from Sikang: " Su-tchuen, autour de Ta-tsien-lou (Pratt, n. 581; *Soulié*, n^{os} 306, 504); Tongolo, Tsha-khio-long-ba, sur les pelouses (Soulié n. 509)." These have not been seen.

In Sikang. Flowers yellow. No specimen seen.

According to Franchet this species has a sparsely hairy calyx with entire teeth densely ciliate on the margins, a corolla-tube twice as long as the calyx, a curved beak, a lower lip that is almost as long as the galea and is bilobed (which may not be constant), and glabrous filaments.

168. **Pedicularis steiningeri** Bonati

Pedicularis steiningeri Bonati, in Bull. Soc. Bot. France, 55: 311, 1908; Limpricht, in Repert. Sp. Nov., 20: 229, 1924. The type " Yargong (*Soulié*) n° 3741, août 1904," has not been seen.

In Sikang. Flower color ?. Flowering in August. Known from the original collection.

This is another uncertain species as yet known only from the original collection. According to Bonati, it is characterized by the glabrous calyx, the entire calyx-teeth, the very short corolla-tube which is hardly longer than the calyx, the short beak, and the hairy anterior filaments.

169. Pedicularis trichomata *sp. nov.* *Plate 6, fig. 135.*

Planta elata, circiter 3 dm. alta, caulibus singulis simplicibus striatis, parce villosis, dense foliatis; foliis caulinis alternis sessilibus, utrinque glabris, lineari-lanceolatis, 3.5-4.5 cm. longis, 5-6 mm. latis, apice acutis vel acuminatis, basi subamplexicaulibus, auriculatis, ad 1 cm. latis, ad apicem gradatim attenuatis, margine numerose breviterque crenato-serratis, dentibus obtusis, minimis, vix 1 mm. longis latisque, denticulatis; inflorescentiis terminalibus spicatis, compactis, circiter 7 cm. longis; floribus subsessilibus, densis; bracteis foliaceis, lanceolatis, crenatis, 1½ ad 2- plo quam floribus longioribus; calyce oblongo-ovoideo, circiter 10 mm. longo 5 mm. lato, dentibus exceptis glabro, 5-dentato, nervis prominentibus, haud reticulatis, dentibus aequalibus vel subaequalibus, deltoideis, acutis, inconspicue serrulatis vel subintegris, parce ciliatis; corollā luteā (?), circiter 2-2.5 cm. longā: tubo erecto, calycem subaequante, glabro; galeā circiter 1-1.5 cm. longā, erectā, vix curvatā, medium versus dilatatā, ovatā, margine inferiore ad medium dense longeque barbatā, pilis ad 3 mm. longis, albidis, caeterum glabrā, apice in rostrum breve contractā; rostro circiter 2 mm. longo, conico, apice truncato, leviter bilobato; labio inferiore galeam subaequante, 3-lobato, lobis subaequalibus, rotundatis, margine interdum inconspicue denticulatis, glabris, lobo medio subporrecto; staminibus ad medium tubi insertis, filamentis longioribus ad apicem dense villosis; inferioribus glabris; stylo exserto; capsulis ignotis.

Type, in northwestern Yunnan, field data not available, collected in flower by T. T. Yü, No. 6437; holotype in the herbarium of the Arnold Arboretum. Only collection seen.

The corolla, as apparent in the dried state, is evidently yellowish. The short corolla-tube shows that this species is undoubtedly more closely related to *P. steiningeri* than to any other species. Also in most other characters these two agree. *P. steiningeri*, of which no specimen has been seen, is described as a tall plant, to 7.5 dm. tall with leaves 5-7 cm. long and inflorescences 40-50 cm. long. The corolla is also larger. The calyx-teeth are described as entire while in this new species they are usually inconspicuously denticulate. It may prove that this new species is only a smaller variety of *P. steiningeri* but without consulting type material of the latter, such a conclusion cannot be reached with certainty.

170. Pedicularis pseudo-ingens Bonati Plate 6, fig. 136.

Pedicularis pseudo-ingens Bonati, in Notes Bot. Gard. Edinb., 8: 135, 1913; 17: 65, 1929; Limpricht, in Repert. Sp. Nov., 20: 230, 1924, p.p.; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 216, 1924. The type, "'N. W. Yunnan, at Atuntsi. Alt. 14,000 ft. July 1911,' F. Kingdon Ward, No. 130," in the Edinburgh Herbarium, has been seen. A photograph is in the herbarium of the Academy of Natural Sciences of Philadelphia.

Among scrub, at altitudes of 3660 to 4200 meters, Atuntze, northwestern Yunnan. Flowers rose. Flowering in July.

YUNNAN: Atuntsi, *Ward* 130 (RBGE); Bei-ma-shan, *Forrest* 14395 (ANSP); Atuntze, Bei-ma-shan, *C. W. Wang* 69743 (AA), fruit; Atuntze, *C. W. Wang* 70122 (AA), fruit.

This species has a strongly bent galea with a rather short conical beak and a completely included style. It is most closely related to P. pseudo-steiningeri. From both of them (ex descriptione), it is distinguished by its longer corolla-tube and the distinctly serrate calyx-teeth.

171. **Pedicularis pseudo-steiningeri** Bonati Plate 6, fig. 137.

Pedicularis pseudo-steiningeri Bonati, in Notes Bot. Gard. Edinb., 15: 157, 1926; Limpricht, in Repert. Sp. Nov., 23: 336, 1927; Hand.-Maz., Symb. Sin., 7: 857, 1936. The type was from the Muli territory, now of Sikang Province: "'Szechuan: Muli or Muli Kingdom, southwestern Szechuan. Flowers purple. 10-14,000 ft. June 1922.' J. F. Rock. No. 5560." Isotypes are in the herbaria of the Academy of Natural Sciences of Philadelphia and the University of California.

Open stony meadows on the margins of forests or in spruce forests, at altitudes of about 3000 to 4300 meters in southeastern Sikang. Flowers purple. Flowering from June to August.

SIKANG: mountains southeast of Muli, *Forrest* 22134 (USNH); Litang-Yalung divide, *Ward* 4407 (RBGE); Muli, *Rock* 5560 (ANSP, UC); Mount Mitzuga, west of Muli Gomba, *Rock* 16537 (ANSP, USNH); Mount Siga, northeast of Kulu, *Rock* 17938 (ANSP, USNH); south of Dzampe sheren in Sagi Valley, Muli territory, *Rock* 23798 (NYBG, UC, UP, USNH), 24370 (NYBG, UC, UP, USNH); no precise locality, *Yü* 7004 (AA); Shiangcheng, Dalongwu, *Yü* 13283 (AA); Muli, Kulu, *Yü* 14272 (AA).

According to Bonati this species is very close to *P. steiningeri*, differing in the shorter height, the lower lip much shorter than the galea, and in the form of the galea; it is perhaps only a local variety of that species with dwarfer habit. No specimen of *P. steiningeri* has been seen for this study. According to Bonati's own description it attains a height of 7.5 dm., with a lower lip equal to the galea in length, and the galea is falciform in shape. *P. pseudo-steiningeri* is about 3-4 dm. tall, with a galea falcate with the lower margins dilated at the middle. From the descriptions the two species seem hardly distinguishable, but in the absence of authentic specimens for one of them, both are here tentatively maintained as distinct.

172. **Pedicularis lophotricha** sp. nov. Plate 6, fig. 138.

Planta elata, 3.5-4 dm. alta; caulibus singulis, simplicibus, striatis, hirsutis, foliatis; foliis alternis caulinis, sessilibus, lineari-lanceolatis, 5-6.5 cm. longis, 6-8 mm. latis, costā supra exceptā utrinque glabris, apice acuminatis, basi late auriculatis, 1-1.3 cm. latis, ad apicem gradatim attenuatis, margine saepe breviterque crenato-serratis, dentibus, obtusis, 1-1.5 mm. longis, 1.5-2 mm. latis, acute denticulatis; inflorescentiis terminalibus longe spicatis, 10-17 cm. longis, plus minusve compactis; bracteis superioribus lineari-lanceolatis, serratis, circiter $\frac{2}{3}$ quam corollas longioribus; pedicellis 1-2 mm. longis; calyce oblongo-ovoideo, circiter 1.2 cm. longo 5 mm. lato, saepe costato, dentibus exceptis glabro haud reticulato, 5-dentato, dentibus subaequalibus, oblongo-triangularibus, integris vel obscure dentatis, ciliatis; corollā luteā, circiter 3 cm. longā: tubo recto glabro quam calycem $1\frac{1}{2}$ plo longiore; galeā circiter 1.4 cm. longā, plus minusve erectā, medium versus leviter dilatatā, margine inferiore ad medium valde dense longeque barbatā, caeterum glabrā, apice in rostrum abrupte curvatum productā, rostro 2-4

mm. longo, apice valde bilobato; labio galeam subaequante, 3-lobato, lobis subaequalibus, subrotundatis, interdum inconspicue denticulatis, glabris; staminibus ad medium tubi insertis, filamentis superioribus dense hirsutis, inferioribus ad apicem sparse hirsutis; stylo subexserto; capsulis ignotis.

Type, in willow scrub, at altitudes of 4370 to 4700 meters, Mount Konka, Risonquemba, Konkaling, in Sikang Province, collected in flower, June 1928, by J. F. Rock, No. 16399; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotype in the United States National Herbarium. Flowers yellow.

SIKANG: Konkaling, *Rock* 16399 (ANSP, USNH); no precise locality, *Forrest* 28631 (ANSP).

This species resembles *P. pseudo-steiningeri* in both the vegetative and the floral structures. However, it differs from the latter, which is geographically located to the southeast, in the serrations of the leaves being shallower (about ¼ to ⅓ the length from the margin to the midrib; while in *P. pseudo-steiningeri* the serrations are about ⅓ to ½ the length), the corolla yellow, the calyx-teeth relatively longer and narrower, the galea abruptly curved at its apex at the junction of the beak while the beak is also more strongly bilobed at the tip, and the 4 filaments are all hairy although the posterior ones are only sparsely so distally.

173. Pedicularis trichocymba sp. nov. Plate 7, fig. 139.

Planta elata robusta, circiter 6 dm. alta; caulibus singulis, simplicibus, glabris, striatis, valde foliatis; foliis caulinis, alternis, lineari-lanceolatis, 6.5-7.5 cm. longis, 7-10 mm. latis, utrinque glabris, apice acutis, basi auriculatis, circiter 1.2 cm. latis, margine saepe crenato-serratis, dentibus obtusis, circiter 2 mm. longis 1.5 mm. latis, acute denticulatis; inflorescentiis terminalibus spicatis circiter 15 cm. longis; foliis inferioribus distantibus, superioribus approximatis; bracteis foliaceis, lineari-lanceolatis, crenato-serratis, flores superantibus; pedicellis 1-1.5 mm. longis; calyce tubuliformi, 8-10 mm. longo, glabro, dentibus exceptis haud reticulato, 5-dentato, dentibus aequalibus, triangulari-oblongis, acutis, inconspicue serrulatis vel subintegris; corollā luteā (?), 2.4-2.6 cm. longā: tubo recto, calycem duplo superante; galeā circiter 8-10 mm. longā, basi rectā, supra curvatā, margine inferiore breve contractā, rostro conico, vix 2 mm. longo, apice truncato, leviter bilobato; labio galeam aequante, basi constricto, recto, supra 3-lobato, lobis subaequalibus, rotundatis, margine interdum leviter denticulato, glabro; staminibus ad medium tubi insertis, filamentis anterioribus ad apicem hirsutis, posterioribus glabris; stylo breviter exserto, capsulis ignotis.

Type, at altitudes of 2745 to 4730 meters, en route from Baurong to Tachienlu, via Hadjaha, Sikang Province, collected in flower, May-June 1929, by Herbert Stevens, No. 535; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotype in the herbarium of the Chicago Museum of Natural History. Flowers yellow (?).

SIKANG: Baurong to Tachienlu, via Hadjaha, *Stevens* 529 (CM), 535 (ANSP, CM).

The species is probably related to *P. tongolensis* which it resembles especially in the relatively long corolla-tube, though otherwise the corollas of the two plants are different. *P. tongolensis* was described as having glabrous filaments, while in this new species the anterior filaments are hairy distally. *P. trichocymba* is also characterized by the stipitate lower lip, the more or less narrowed and elongated base being somewhat erect and parallel to the lower part of the galea. The flower color is not indicated on the label, but judging from that in the dry condition, which is yellowish brown, the original color must have been yellow.

Series 46. Trichoglossae ser. nov.

Tall, erect, plants; roots simple, slightly thickened, with a tuft of fibrous roots above; stems simple, pubescent; leaves cauline, alternate, sessile, oblong-linear to linear-lanceolate, pinnatifid, the lobes numerous, dentate; inflorescences elongate; flowers lax or dense; bracts foliaceous, pinnatifid, as long as or shorter than the flowers; pedicels short; calyx ovoid, glabrous to pubescent, cleft anteriorly, scarcely reticulate, 5-dentate; the teeth subequal, ovate-oblong, obtuse, serrate, ciliate on the margins; corolla purple, the tube shorter or slightly longer than the calyx, erect or bending, pubescent externally; galea strongly curved, densely long and reddish- or purplish-hairy on the margins and above, produced into a long slender beak, the beak cylindric, bending, pointing downward; lower lip broad, 3-lobed, the lobes subequal to unequal, the median rounded, the lateral reniform, glabrous or ciliate on the margins; stamens inserted at the middle of the tube, the filaments all glabrous; stigmas exserted.

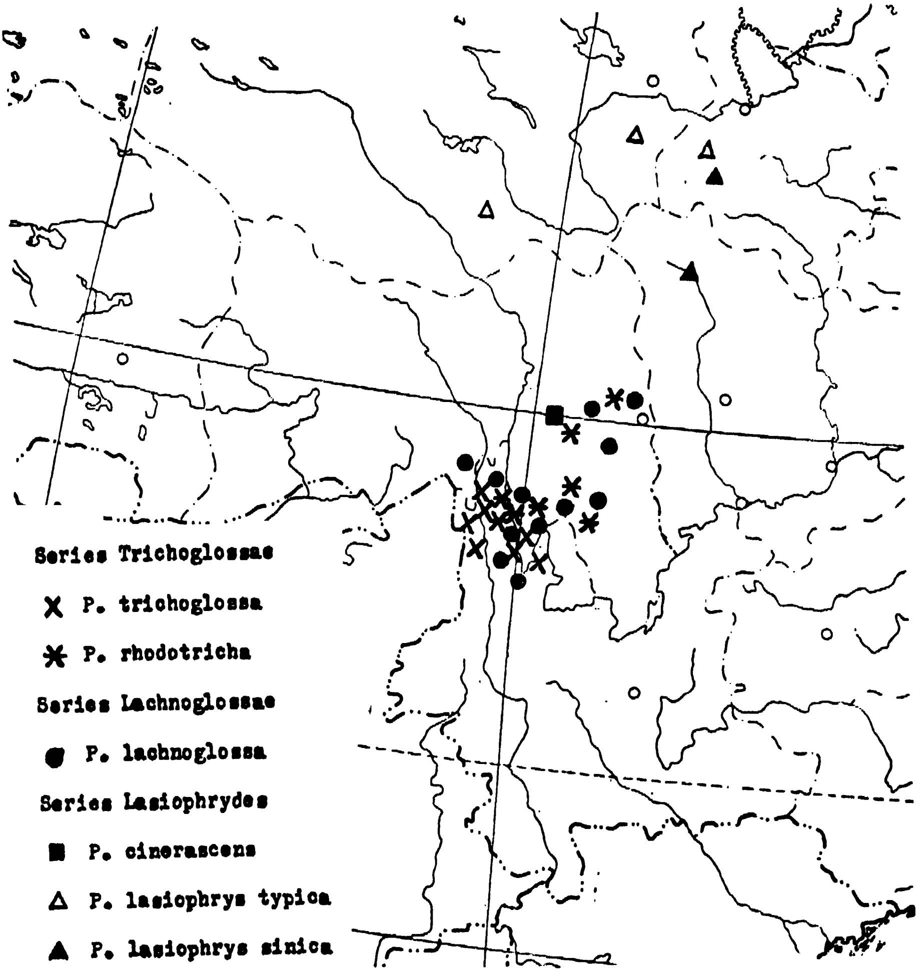
About 2 species from southern Sikang and northwestern Yunnan, to the eastern and central Himalayas (Map 26).

The two species of this series are strongly characterized by the pubescent corolla, sparsely so on the tube but densely so on both the upper surface and the margins of the galea. In this respect they are readily distinguished from the related series Craspedotrichae and Lasiophrydes. Other distinct characteristics of the series are the strongly curved galea with its long curved beak which points downward and the broad lower lip with reniform lateral lobes.

Key to the Species

A. **Leaves longer and relatively narrower, to about 5.5 cm. long and 1.2 cm. wide, with 20-25 lobes on each side, the lobes cut to about ½ the length from the margins to the midrib; corolla-tube bending, the beak very long, strongly curved; margins of the lower lip glabrous. .... 174. *P. trichoglossa***

AA. **Leaves shorter and relatively broader, to 3.5 cm. long and 1.2 cm. wide, with 8-12 lobes on each side, the lobes cut to about ⅔ the length from the margins to the midrib; corolla-tube erect, the beak bending downward only; margins of the lower lip ciliate. .... 175. *P. rhodotricha***



Map 26.—Distribution of the series Trichoglossae, Lachnoglossae, and Lasiophrydes.

174. Pedicularis trichoglossa J. D. Hooker Plate 7, fig. 140.

Pedicularis trichoglossa Hook. f., Fl. Brit. Ind., 4: 310, 1884; Maxim., in Bull. Acad. St. Pétersb., 32: 566, fig. 63, 1888; in Mél. Biol., 12: 842, fig. 63, 1888; Limpricht, in Repert. Sp. Nov., 20: 229, 1924; 23: 336, 1927; Bonati, in Notes Bot. Gard. Edinb., 15: 157, 1926; 17: 87, 1929; Marquand, in Journ. Linn. Soc. Bot., 48: 214, 1929; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 222, 1934; Hand.-Maz., Symb. Sin., 7: 857, 1936. The type was from "Sikkim and E. Nepal Himalaya; Wallenchoon, Momay and Tungu, alt. 12-13,000 ft., *J. D. H*[*ooker*]." Maximowicz studied this type collection as well as other specimens from the Himalayas, depicted the flower and added a more detailed description.

Open stony meadows in forests at altitudes of 3600 to 5000 meters, through the central and eastern Himalayas to Yunnan. Flowers purple. Flowering in July and August.

Yunnan: Mekong-Salween divide, *Forrest* 14664 (UCLA), 20001 (ANSP); northwestern flank of the Likiang Range, *Forrest* 12782 (ANSP, UCLA); Chungtien, *Schneider* 2369 (UCLA, USNH), *Forrest* 10896 (ANSP, UC), *Feng* 1711 (AA); Salween-Kiukiang divide, *Forrest* 19965 (UCLA); Likiang, *Schneider* 3352 (USNH); Dokerla, A-tun-tze, *C. W. Wang* 64944 (AA), *Yü* 7917 (AA); Bai-mar-shan, A-tun-tse, *C. W. Wang* 69447 (AA); Upper Kiukiang valley (Clulung), Tsugum, *Yü* 19772 (AA); no locality, *Yü* 12455 (AA), 12786 (AA); Mount Shwemenkan, between the Chungtien River and the Yangtze, northwest of the Likiang Snow Range, *Rock* 9738 (NYBG, USNH); mountains of Monting, northwest of the Yangtze-Mekong watershed, *Rock* 10344 (ANSP, GH, UC, USNH); Mount Lo-Ch'ou-Kha, southwest of Chungtien, *Rock* 17252 (ANSP, USNH), 17268a (ANSP, USNH); mountains of Nakela, east of Yuragan, Mekong-Salween divide, *Rock* 23435 (UC, UP); Haba Shan, north of the Yangtze loop, third peak of Likiang Snow Range, Bardar, *Rock* 24770 (CM, MBG, NYBG, UC, UP, USNH).

The Yunnan plant, in comparison with the Indian plant of the same species, appears to have narrower and longer leaves and more numerous pinnate lobes and less prominently serrate calyx-teeth. Otherwise it is so close to the typical form of the species from India as to make one refrain from taxonomically distinguishing the two in any category.

175. **Pedicularis rhodotricha** Maximowicz Plate 7, fig. 141.

Pedicularis rhodotricha Maxim., in Bull. Acad. St. Pétersb., 32: 566, fig. 64, 1888; in Mél. Biol., 12: 843, fig. 64, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 215, 1890; Diels, in Bot. Jahrb., 29: 572, 1900; Bonati, in Bull. Herb. Boiss., II, 7: 544, 1907; in Bull. Soc. Bot. France, 54: 186, 1907; in Notes Bot. Gard. Edinb., 8: 41, 1913; 15: 157, 1926; 17: 81, 1929; Limpricht, in Repert. Sp. Nov. Beih., 12: 484, 1922; in Repert. Sp. Nov., 20: 229, 1924; 23: 336, 1927; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 218, 1934; Hand.-Maz., Symb. Sin., 7: 857, 1936. The types were from " prov. Sze-tschuan districtu Moupine 5000 m.s.m. (David! in herb. Paris.), prov. Yunnan, supra Hokin monte Koua-la-po 3500 m.s.m (David!)." The first locality is in southwestern Szechuan and the second in northwestern Yunnan. A sheet of *Delavay* s.n. (ex Herb. Mus. Paris), from Yunnan but without exact locality, is in the Bonati Herbarium; it will be divided between the Academy of Natural Sciences of Philadelphia and the University of California at Los Angeles. This sheet contains six specimens and may be a duplicate of one of the syntypes. In the herbarium of the New York Botanical Garden, on the same sheet bearing the label of *Soulié* 2881, there is a label of *Delavay*, Aug. 5, 1883, bearing the same data as the syntype, and apparently of the same collection. This label may be referrable to the two lower specimens on the sheet, which consist in both cases of inflorescences only, while the two upper and more complete ones on the same sheet are apparently those of *Soulié's* collection.

"*Pedicularis trichoglossa*" *sensu* Franch,. in Nouv. Arch. Mus. Hist. Nat. Paris, II, 10: 67, 1886. (Pl. David. II); *non* Hook. f. Based on a David collection from Moupine, Szechuan, one of the syntypes of *P. rhodotricha* Maxim.

Alpine meadows at altitudes of 2660 to 4000 meters in northwestern Yunnan, southeastern Sikang, and southwestern Szechuan. Flowers purple. Flowering from June to August.

Western China: without precise locality, *Wilson* 4240 (UCLA).

Sikang: no precise locality, *Soulié* 2869 (NYBG); Tche-to-chan, *Soulié* 2881 (NYBG, UCLA); Litang-Yalung divide, *Ward* 1406 (RBGE); mountains between the Litang and Shou-chu Rivers, between Wa-Erh-Dje and Garu, *Rock* 16755 (ANSP, USNH); mountains southeast of Muli, *Forrest* 22121 (UC, USNH); western slopes of Mt. Mitzuga, Muli territory, *Rock* 23978 (MBG, NYBG, UC, UP, USNH), 24546 (NYBG, UC, UP, USNH); Baurong to Tachienlu, via Hadjaha, *Stevens* 311 (CM).

Yunnan: no precise localities, *Delavay* s.n. (ANSP, UCLA), *Forrest* 28525 (ANSP), 28846 (ANSP), *Yü* 12656 (AA); Ho-kin, *Delavay* s.n. (NYBG); northeast of the Yangtze bend, *Forrest* 10489 (UC); Chungtien Plateau, *Forrest* 10789 (ANSP, UC), *Schneider* 2200 (USNH); Mekong-Salween divide, *Forrest* 14588 (UCLA); eastern slopes of Likiang Snow Range, *Forrest* 6659 (UCLA), *Rock* 5272 (ANSP, GH, UC, USNH); Kin-tzu Shan or Dscho-yu nviu, district of Labako, west of Shi-ku, *Rock* 25138 NYBG, UC, UP, USNH); A-tun-tze, Bai-ma Shan, *C. W. Wang* 69684 (AA); southeastern Chungtien, Pai-lun Shan, near Anangu, *Feng* 2008 (AA); northeastern Likiang, Tzai-koo Snow Mountains, *Ching* 21183 (AA).

The species is related to *P. trichoglossa*. The leaves of *P. trichoglossa* are narrower and longer, with 20-25 lobes on each side, while those of *P. rhodotricha* are shorter and broader and with 8-12, more or less distinct, lobes on each side. The inflorescences of *P. trichoglossa* are longer (to 12 cm.) with more numerous flowers, while those of *P. rhodotricha* are shorter (4-5 cm.) with fewer flowers. In the floral characters, *P. trichoglossa* has a more densely pubescent calyx, shorter and strongly curved corolla-tube and semi-circular beak, and narrower lower lip with subequal lobes and glabrous margins. In *P. rhodotricha* the calyx is almost glabrous except the upper part and the teeth, the corolla-tube is longer and straight, the beak arched but not strongly coiled, and the lower lip is much broader with a smaller median lobe and ciliate margins.

Series 47. Lachnoglossae

Lachnoglossae Prain, in Ann. Bot. Gard. Calcutta, 3: 81, 1890, p.p.

Tall, erect plants; roots very much thickened; stems simple, glabrate; leaves mostly radical, clustered, few cauline, these alternate, very much smaller in size, radical leaves long-petiolate, linear-oblong, pectinately pinnatisect, the leaflets linear, serrate; inflorescences elongate, more or less lax; bracts linear-lanceolate, serrate, about as long as or longer than the calyx; calyx ovoid, cleft anteriorly, 5-dentate, the teeth entire to obscurely serrate; corolla purple, the tube slightly bending, the galea hairy dorsally and on the lower margins, the beak slender, straight, slightly pointing downward, with a tuft of hairs at the apex; lower-lip strongly 3-lobed, the lobes oblong, acute, the margins densely ciliate; filaments all glabrous.

One species from the eastern Himalayas to northwestern Yunnan and Sikang (Map 26).

Prain originally included some American species in this series. These same species were placed in the series *Compactae* by Limpricht, while *P. lachnoglossa* was included by him in the series Tristes. *P. lachnoglossa* is sufficiently strongly characterized to be removed from the series Tristes and made into a series of its own, Lachnoglossae. It is also very different from the American species associated with it by Prain. Thus, the series Lachnoglossae is here interpreted as monotypic.

176. Pedicularis lachnoglossa J. D. Hooker Plate 7, fig. 142.

Pedicularis lachnoglossa Hook. f., Fl. Brit. Ind., 4: 311, 1884; Maxim., in Bull. Acad. St. Pétersb., 32: 562, fig. 55, 1888; in Mél. Biol., 12: 237, fig. 55, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 210, 1890; Bonati, in Bull. Herb. Boiss., II, 7: 544, 1907; in Bull. Soc. Bot. France, 54: 186, 1907; in Notes Bot. Gard. Edinb., 8: 41, 1913; Limpricht, in Repert. Sp. Nov. Beih., 12: 484, 1922; in Repert. Sp. Nov., 20: 231, 1924; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 213, 1934; Hand.-Maz., Symb. Sin., 7: 857, 1936. The type, "Sikkim Himalaya; Lachen Valley, Alt. 14,000 ft., *J. D. H*[*ooker*]," has not been seen. Description distinctive. The description was elaborated by Maximowicz who also depicted the flower structures. His description and illustration were based on both the type collection from India as well as *Delavay* s.n. from Yunnan, China. This is apparently the same as *Delavay* 2087 noted in this study.

Pedicularis lachnoglossa Hook. f. var. *macrantha* Bonati, in Notes Bot. Gard. Edinb., 8: 41, 1913; 15: 158, 1926; Limpricht, in Repert. Sp. Nov., 20: 231, 1924; 23: 336, 1927. Bonati's type was from northwestern Yunnan: "'Open mountain meadows on the eastern flank of the Lichiang Range. Lat. 27° 35′ N. Alt. 11,000 ft. June, 1910.' G. Forrest. No. 5821." An isotype from the Bonati Herbarium passes to the Academy of Natural Sciences of Philadelphia. This proves to be identical with the typical form. See notes below. This variety was also made into a species by Léveillé as follows:

Pedicularis macrantha (Bonati) Léveillé, Cat. Pl. Yunnan 263, 1917, *non* Spreng. 1827, *nec* Klotzsch 1862. Based on *P. lachnoglossa* var. *macrantha* Bonati.

Alpine meadows or in spruce forests at altitudes of 3500 to 5335 meters in the eastern Himalayas, northwestern Yunnan, and Sikang. Flowers rose to purple. Flowering in June and July.

SIKANG: Kiala, *Soulié* 186 (ANSP, UCLA); Tongolo, *Soulié* 290 (UCLA); Talien Mts., *Wilson* 4224 (UCLA); Litang-Yalung divide, *Ward* 4438 (RBGE); Baurong to Tachienlu, via Hadjaha, *Stevens* 531 (ANSP, CM); Mount Mitzugo, west of Muli Gomba, *Rock* 16229 (ANSP, USNH); Mount Konka, Risonquemba, Konkaling, *Rock* 16392 (ANSP, USNH); mountains of Kulu, *Rock* 18085 (ANSP, USNH), 18204 (ANSP, USNH); Dzampe sheren mountain, west of Wuato Jomba, eastern Muli, *Rock* 23758 (MBG, NYBG, UC, UP, USNH); Dzampe sheren, *Rock* 24333 (NYBG, UC, NYBG); Muli, *Forrest* 28387 (ANSP); Tsa-wa-rung, sacred Mt. Kar-car-kar-boo, *C. W. Wang* 66225 (AA); Muli, Kulu, *Yü* 14292 (AA).

YUNNAN: Hokin, *Delavay* 2087 (ANSP, UCLA); Likiang Range, *Schneider* 1934 (USNH), *Handel-Mazzetti* 3876 (GH, USNH), *Forrest* 5821 (ANSP), 10111 (UCLA); eastern slope of Likiang Range, *Rock* 3940 (NYBG, USNH), 4227 (ANSP, UC, USNH), 4495 (GH, NYBG, USNH), 5650 (USNH), 6155 (ANSP, UC, USNH); eastern slope of Likiang Snow Range, Mt. Satseto, *Rock* 24960 (NYBG, UC, UP, USNH); Sung-kwe pass between Likiang and Ho-kin, south of Likiang, *Rock* 25186 (NYBG, UC, UP, USNH); Yu-lung Shan, Likiang Snow Range, *Rock* 25335 (UC); Likiang District, *C. W. Wang* 70943 (AA); Likiang Snow Range, *Yü* 15437 (AA); northeastern Likiang, Tzai-koo Snow Mt., *Feng* 2523 (AA); southwestern slope of Likiang Snow Range, Ganhaitze, *Ching* 21131 (AA); northeastern Likiang, Ta-koo on the Yangtze, *Ching* 21211 (AA); A-tun-tze, *C. W. Wang* 70103 (AA); A-tun-tze, Bei-ma-shan, *Yü* 10886 (AA); Chungtien, Haba, *Yü* 13517 (AA); northern flank of the Haba Snow Range, *Feng* 1259 (AA); no precise localities, *Forrest* s.n. (NTU), 28496 (ANSP), *Yü* 6129 (AA), 11654 (AA).

A species strongly characterized by the rosette of long-petiolate, narrow and pectinately pinnate radical leaves, the densely hairy galea and beak with a tuft of hairs at the apex, and the strongly 3-lobed lower lip with the lobes acute and densely hairy along the margins.

Bonati described the var. *macrantha* mentioning the differences from the typical form in (1) the entire calyx-teeth, (2) the larger flowers (2 cm.) with the galea totally villose, (3) the lower lip much larger with the lip rounded, not attenuate, and (4) the stems more foliolate, the flowers sessile. While some of the characters are notable in certain specimens, nevertheless, intergradations are common. Neither do the variations associate to any extent with geographical difference as Indian plants are similar to Chinese plants in all respects. Thus the variety *macrantha* Bonati is here treated as essentially the same as the typical form. Handel-Mazzetti (l.c.) expressed a similar opinion when he cited *Handel-Mazzetti* 3876 under *P. lachnoglossa:* " Die gesammelte Pflanze entspricht der var. *macrantha* Bont. l.c., VIII., 41 (1913), die aber vom Typus kaum verschieden ist."

Series 48. Lasiophrydes ser. nov.

Erect, medium-sized or low plants; roots simple, with a tuft of fibrous roots near the top; stems simple, usually hairy; leaves cauline, alternate, sessile to subsessile, linear to lanceolate, narrowed at base, numerously crenate-pinnatifid, the lobes obtuse, dentate; inflorescences short, compact; bracts foliaceous, subentire, shorter than the flowers; pedicels very short; calyx ovoid, pubescent, slightly cleft anteriorly, scarcely reticulate, 5-dentate, the teeth subequal, deltoid, acute, entire; corolla yellow or pale rose, the tube as long as or longer than the calyx, erect, glabrous; galea bending in the middle, densely hairy on the lower margins, glabrous otherwise or hairy in front, the apex produced into a slender cylindric beak, the beak more or less straight, horizontal; lower lip 3-parted to the base or nearly so, the lobes subequal, rounded, entire, glabrous, stipitate proximally; stamens inserted near the middle of the tube, the filaments all glabrous; stigmas slightly exserted.

About 2 species in Sikang, eastern Chinghai, Kansu, and northern Szechuan (Map 26).

This series is strongly characterized by the 3-parted lower corolla-lip, the lobes being stipitate proximally and rounded distally. The strictly entire calyx-teeth are distinctive. Phylogenetically, in addition to its relationship with the Tristes, Craspedotrichae, and Trichoglossae, this series is also close to the Lachnoglossae, although they are readily distinguishable.

Key to the Species

A. Corolla whitish rose; galea glabrous dorsally, lower lip of corolla deeply 3-parted to nearly the base. .... 177. *P. cinerascens*

AA. Corolla yellow; galea hairy in front; lower lip of corolla completely 3-parted to the base. .... 178. *P. lasiophrys*

177. Pedicularis cinerascens Franchet Plate 7, fig. 143.

Pedicularis cinerascens Franch., in Bull. Soc. Bot. France, 47: 30, 1900; Bonati, in Bull. Herb. Boiss., II, 7: 544, 1907; in Bull. Soc. Bot. France, 54: 186, 1907; Limpricht, in Repert. Sp. Nov. Beih., 12: 484, 1922; in Repert. Sp. Nov., 20: 231, 1924. The types were from Sikang: " Su-tchuen, Ta-tsien-lou (Mussot, n. 279); Tongolo, dans les broussailles (Soulié, n. 312)." A duplicate of the syntype, *Soulié* 312, is in the herbarium of the Academy of Natural Sciences of Philadelphia.

In Sikang. Flowers whitish rose. Flowering in July.

SIKANG: Tongolo, *Soulié* 312 (ANSP, UCLA); Kojilatho, route de Tha-gong, *Soulié* 2844 (ANSP, UCLA); Derge, *Laufer* 13 (CM).

This species is related to *P. lasiophrys* Maxim. and *P. craspedotricha* Maxim. It differs from *P. lasiophrys* in the leaf-bases being not broadened, the corolla being rose-colored, the galea ciliate on the lower margins but glabrous above, and the lower lip deeply but not completely 3-lobed, the lobes being broadly rounded. From *P. craspedotricha* it differs in having hairy instead of glabrous calyx, in the longer and more slender beak, and in the lobes of the lower lip being more strongly narrowed at base.

178. **Pedicularis lasiophrys** Maximowicz

Key to the Varieties

A. Galea hairy near the tip and along the lower margins, but not dorsally and on the corolla-tube; lower lip as long as the galea, glabrous on the margins. 178a. *P. l. typica*

AA. Galea hairy near the tip and along the lower margins as well as dorsally and on the corolla-tube; lower lip as long as or slightly shorter than the galea, ciliate on the margins. .... 178b. *P. l. sinica*

178a. **Pedicularis lasiophrys** typica Plate 7, fig. 144.

Pedicularis lasiophrys Maxim., in Bull. Acad. St. Pétersb., 24: 68, 1878; 32: 564, fig. 57, 1888; in Mél. Biol., 10: 104, 1877; 12: 839, fig. 57, 1888; Limpricht, in Repert. Sp. Nov., 20: 230, 1924; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 33, 1933; Pai, in Contr. Inst. Bot. Acad. Peiping, 2: 214, 1934. The type was from Kansu: "Kansu, pratis montanis et alpinis, in his frequentibus (Przewalski)." It has not been seen. Description and illustration distinctive.

Alpine meadows at altitudes of 3700 to 6000 meters, in Kansu and eastern Chinghai. Flowers yellow. Flowering in July.

Chinghai: Amnyi Machen Range (west of Yellow River), Mt. Druggu, *Rock* 14439 (ANSP, GH); Wanchen nang Valley between Labrang and Yellow River, *Rock* 14525 (ANSP, GH, NYBG, USNH).

A distinct species especially characterized by the completely 3-parted lower lip of the corolla and the hairy galea. It is nearest to *P. cinerascens* Franch., from which it may be readily distinguished by the hairy galea, the completely 3-parted lower lip and the beak with entire instead of bilobed apex.

178b. **Pedicularis lasiophrys sinica** Maximowicz

Pedicularis lasiophrys var. *sinica* Maxim., in Bull. Acad. St. Pétersb., 32: 564, 1888; in Mél. Biol., 12: 839, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 211, 1890; Limpricht, in Repert. Sp. Nov., 20: 230, 1924; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 33, 1933. The types were from: "*Kansu* orientali: cacumine montis Tschagola, *Sze-tschuan* boreali: trajectu Gumà-kikà, nec non circa fontes fl. Atu-Lumva (Potanin, 1885)." They have not been seen.

Alpine meadows at altitudes of about 2900 meters in Kansu and northern Szechuan. Flowers yellow. Flowering in July and August.

Kansu: T'ao River basin, Adjuan, *Rock* 12850 (ANSP, GH, NYBG).

Szechuan: Sungpan District, *Fang* 4032 (ANSP, GH, USNH).

Series 49. Recurvae ser. nov.

Plants tall, erect; roots clustered, fibrous, slightly thickened; stems single or sometimes several together, simple, glabrous or nearly so; leaves cauline, alternate, few, the lower long-petiolate, the upper smaller and sessile, the blades oblong to oblong-lanceolate, pinnatisect, the segments oblong-lanceolate to lanceolate, remote, pinnatifid to serrate; flowers long-spicate, the upper bracts linear to ovate, more or less hairy; calyx membranaceous, glabrous, slightly reticulate or not, slightly cleft anteriorly, 5-dentate, the teeth subequal, deltoid, entire, more or less densely ciliate along the margins; corolla purple or red, the tube more or less erect, as long as or longer than the calyx; the galea strongly bent, densely villose in front and on the margins, produced into a distinct, conical, recurved beak; lower lip narrower, 3-lobed, the lobes subequal to unequal, slightly ciliate on the margins, usually ovate and acute, sub-denticulate or the median prolonged and rounded; filaments glabrous, anthers broadly oval.

Two species from northwestern Yunnan to Sikang, northern Szechuan, and southern Kansu (Map 27).

The two species of this series are distinct enough by themselves to be segregated into a series to be distinguished from the series Tristes or Proboscideae. Bonati and Limpricht included *P. recurva* in Tristes and Prain in Proboscideae. The characteristic features of the series are the recurved beak and the narrow lower lip. The broad anthers and the clustered root system also show its difference from the species of the former series.

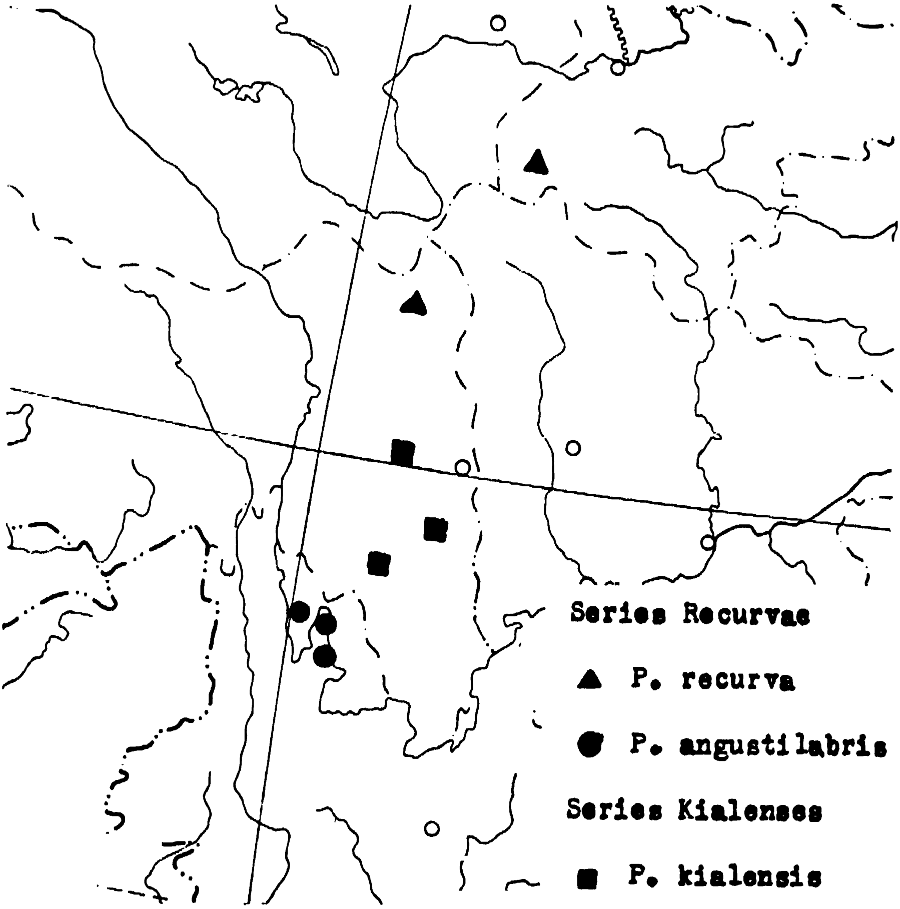
Key to the Species

A. Leaf-segments 9-11 on each side; upper bracts linear-lanceolate; calyx 5-6-nerved, not reticulate; lower corolla-lip very unequally 3-lobed, the lateral lobes very short, somewhat acute and denticulate, the median lobe very long, much produced, more or less rounded and entire. .... 179. *P. recurva*

AA. Leaf-segments 15-18 on each side; upper bracts broadly ovate; calyx 8-10-nerved, slightly reticulate; lower corolla-lip sub-equally 3-lobed, the lobes acute and subdenticulate, the median lobe very slightly longer. .... 180. *P. angustilabris*

179. **Pedicularis recurva** Maximowicz Plate 7, fig. 145.

Pedicularis recurva Maxim., in Bull. Acad. St. Pétersb., 32: 563, p.p. excl. fig. 59, 1888; in Mél. Biol., 12: 838, p.p. excl. fig. 59, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 214, 1890, p.p.; Bonati, in Bull. Herb. Boiss., II, 7: 544, 1907; Limpricht, in Repert. Sp. Nov., 20: 230, 1924, p.p.; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 34, 1933. Maximowicz originally cited two collections: "Sze-tschuan boreali: vallibus fluviorum Heiho et Ksernzo (Potanin, 1885), prov. Yunnan: Likiang, ad pedem glaciei, 3800 m. s.m. (Delavay! in Mus. Paris)." These represent two different elements. In the Bonati Herbarium there is a *Delavay* s.n., from Yunnan but without field notes which may be a duplicate of the Delavay number cited by Maximowicz. Of the two collections cited, the Potanin plant was apparently the one that was used as the basis of the description while the Delavay one was used as the basis for the illustration. Both *Delavay* s.n. from Yunnan, as well as other specimens from the same province, agree well with the illustration in the more numerously nerved and somewhat reticulate calyx and also the lower lip of the corolla with its subequal lobes. They contradict the description given by Maximowicz in having the lobes of the corolla-lip subequal; also in having broadly ovate instead of linear-lanceolate bracts, and in having 15-18 instead of



Map 27.—Distribution of the series Recurvae and Kialenses.

9-11 leaf-segments. Inasmuch as the description was clearly based on the Potanin collection which was the only one that Maximowicz had in his own herbarium at St. Petersburg, it is to be taken as the type in spite of the discrepancy of the illustration. The Delavay collection seen at the Paris Museum represents a related form that occurs in Yunnan; it is here being removed from the species and included in the conception of *P. angustilabris*. Consequently the Yunnan plants cited by various authors as *P. recurva* are referable to the latter.

On boulders or rock walls, at an altitude of about 3350 meters, in northeastern Sikang and southwestern Kansu. Flowers pale red. Flowering in July and August.

Kansu: Upper Tebbu county, *Rock* 13097 (ANSP, GH).

This species is strongly characterized by its long conical recurved beak densely hairy on the proximal part and the margins, and its elongated upper lip. The lower lip is shortly 3-lobed, the two lateral lobes being very short, somewhat acute and denticulate, while the median lobe is much elongated, projecting and entire. The bracts are linear-lanceolate and the calyx is very membranaceous, few-nerved, and not reticulate.

180. Pedicularis angustilabris sp. nov. Plate 7, fig. 146.

Pedicularis recurva var. *polyantha* Bonati, in Notes Bot. Gard. Edinb., 5: 88, 1911; 7: 152, 1912; 8: 41, 1913; 15: 158, 1926; Limpricht, in Repert. Sp. Nov., 20: 230, 1924; 23: 336, 1927; Hand.-Maz., Symb. Sin., 7: 857, 1936. The type was from northwestern Yunnan: "'At the base of cliffs on the eastern flank of the Lichiang Range. Lat. 27° 25′ N. Alt. 11-12,000 ft. August 1906' G. Forrest, No. 2667." Three isotypes are in the Bonati Herbarium. See note below.

Pedicularis recurva Maxim., in Bull. Acad. St. Pétersb., 32: 563, p.p. fig. 59, 1888; in Mél. Biol., 12: 838, p.p., fig. 59, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 214, 1890, p.p.; Limpricht, in Repert. Sp. Nov., 20: 230, 1924, p.p. *Delavay* s.n. from Yunnan originally cited with *Potanin* s.n. from "northern Szechuan" by Maximowicz are found to be two different plants. See note under *P. recurva* Maxim. Yunnan plants, originally referred to *P. recurva* or *P. recurva polyantha* are here designated as representing a new species. Maximowicz's original illustration for *P. recurva*, as explained under that species, is apparently referable to this new species.

Planta elata 6-7 dm. alta; radicibus plurimis, subcrassis; caulibus singulis vel plurimis, subtenuibus, rigidibus, (inflorescentiis exceptis) glabris, foliatis; foliis caulinis, sparsis, paucis, inferioribus longe petiolatis (petiolis gracilibus, ad 12 cm. longis, glabris), superioribus sensim minoribus, subsessilibus vel sessilibus, laminis oblongis vel oblongo-lanceolatis, acuminatis, ad 13 cm. longis 5.5 cm. latis, pinnatifidis, rhachidibus plus minusve alatis, utrinque leviter hirsutis, segmentis utrinque 15-18, remotis, oblongo-lanceolatis vel lanceolatis, ad 2.6 cm. longis et 1.3 cm. latis, acutis, pinnatifidis serratisve, utrinque glabris; inflorescentiis longe terminalibus spicatis, ad 18 cm. longis, leviter hirsutis, multifloris; floribus sessilibus, plus minusve laxis; bracteis inferioribus foliaceis, superioribus ovatis, acutis, circiter 6 mm. longis, 4-5 mm. latis, hirsutis; calyce cylindrico-ovoideo antice leviter fisso, membranaceo, margine (dentibus exceptis) glabro, circiter 6 mm. longo, 4 mm. lato, 8-10-costato, leviter reticulato, 5-dentato, dentibus subaequalibus, deltoideis, margine dense ciliatis; corollā purpureā, circiter 1.5 cm. longā: tubo calycem leviter superante vel duplo longiore, plus minusve recto, glabro; galeā valde curvatā, horizontali, antice margineque dense villosā, apice in rostrum conicum gradatim productā, galeā quam rostrum circiter 1 cm. longiore, rostro distincte recurvo, margine inferiore villosā; labio circiter 7 mm. longo, angusto, 3-lobato, acuto, inconspicue dentato, margine plus minusve ciliato; staminibus ad medium tubi insertis, filamentis glabris, antheris late ovatis; stylo incluso vel subexserto; capsulis ovoideis, haud compressis, acutis, circiter 1 cm. longis 5 mm. crassis, apice dehiscentibus, calycibus omnino inclusis.

Type, at an altitude of about 3660 meters, Mount Habashan, north of Ndaku, north of the Likiang Snow Range, Yangtze drainage basin, northwestern Yunnan, collected in flower, July 1923, by J. F. Rock, No. 9653; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotypes in the Gray Herbarium, the herbarium of the University of California, and the United States National Herbarium.

In alpine meadows at altitutdes of 3000 to 4000 meters, in northwestern Yunnan and Sikang (?). Flowers purplish red. Flowering in July.

WESTERN CHINA: no precise locality, *Wilson* 4253 (UCLA).

YUNNAN: no precise locality, *Delavay* s.n. (UCLA), *Forrest* s.n. (ANSP, NTU, UCLA); eastern slopes of the Likiang Snow Range, *Forrest* 2667 (ANSP, NTU, UCLA), 6246 (UCLA), *Rock* 5011 (NYBG, USNH), 9915 (USNH), 11656 (ANSP, UCLA, USNH); Mount Habashan, north of Ndaku, north of the Likiang Snow Range, Yangtze drainage basin, *Rock* 9653 (ANSP, GH, UC, USNH); Likiang Snow Range, *Ching* 30453 (AA); southwest of Hsiao—Chungtien, Kung-shiang-shu Snow Mt., *Feng* 1765 (AA).

This species is closely akin to *P. recurva* but is clearly differentiated by its more numerous leaf-segments, its much broader bracts, its slightly reticulate calyx and its subequally lobed lower lip. The corolla also appears to have a much darker color. In both *P. recurva* and this new species the corollas are frequently found to have dark spots in the front, although these were not reported by the collectors.

This species appears to be the same as *P. recurva* var. *polyantha* Bonati typified by *Forrest* 2667. Bonati originally distinguished his variety from the typical form of *P. recurva* as: "Caules numerosi. Inflorescentia multiflora. Calycis dentes margine ciliati." It is found, however, that in a few specimens there may be several stems growing together, but in most cases the stem is single. The other characters mentioned by him are scarcely distinct enough. Instead, the Yunnan plants referred by various authors to *P. recurva* and *P. recurva polyantha*, are very different from *P. recurva* as here redefined, and the combination of various characters renders it necessary to recognize a separate species in the south related to but distinct from *P. recurva*.

Series 50. Kialenses ser. nov.

Erect, medium-sized plants; stems many together, simple above, slightly pubescent; leaves mostly radical, long-petiolate, the cauline few, smaller and shorter-petiolate, the blades linear-lanceolate, deeply pinnatifid to nearly pinnatisect, the segments many, ovate, profoundly pinnatifid, the lobes distinctly serrate; inflorescences long, terminal, the flowers more or less distant, the pedicels short to none, the bracts foliaceous, deeply pinnatifid, half as long as the flowers; calyx cylindric, densely villose, scarcely reticulate distally, cleft anteriorly, 5-dentate, the teeth unequal, the mid-posterior very small, subulate, entire, the others stipitate, ovate, distinctly crenate; corolla purple, the tube erect, slightly longer than the calyx, glabrous, the galea strongly twisted, produced into an erect, long, slender, sigmoid beak, the lower margins of the galea and the beak densely villose; lower lip broad, more or less glandulose dorsally near its base, deeply 3-lobed, the lobes rounded, equal, sparsely ciliate on the margins; staminal filaments inserted toward the middle of the tube, the anterior ones hairy distally; stigma scarcely exserted.

One species in eastern Sikang (Map 27).

The relationship of this series is with the Lachnoglossae. It is strongly characterized by the hairiness along the lower margins of the galea and the beak. The galea is strongly twisted and the beak long, slender and sigmoid.

181. **Pedicularis kialensis** Franchet Plate 7, fig. 147.

Pedicularis kialensis Franch., in Bull. Soc. Bot. France, 47: 22, 1900; Bonati, in Bull. Herb. Boiss., II, 7: 542, 1907; Limpricht, in Repert. Sp. Nov., 20: 247, 1924. The type, "Su-tchuen, Tongolo dans les forêts de Sapins (Soulié, n. 611)," has not been seen.

At altitudes of 3050 to 4875 meters in eastern Sikang. Flowers purple. Flowering in June and July.

SIKANG: Tongolo, Principaute de Kiala, *Soulié* 401 (ANSP, UCLA); Muli Territory, Mount Mitzuga, west of Muli Gomba, *Rock* 16573 (ANSP, USNH); Muli Territory between Baurong and Kulu, west of the Yalung River, *Rock* 17852 (ANSP, USNH).

A distinct species strongly characterized by the cylindric, densely hairy calyx, the twisted galea and the long and slender, distinctly sigmoid and upraised beak, as well as the lower margin of the beak being densely hairy. Franchet did not describe the lower corolla-lip. It is deeply 3-lobed, the lobes being rounded and almost equal. The lip is also glandulose dorsally near the base. In its general structure this species suggests *P. davidi* and *P. torta* but their detailed structures are very different. Its calyx resembles somewhat that of *P. rhinanthoides*. Bonati placed this species in the series Megalanthae (in Bull. Soc. Bot. France, 57, Mém. 18: 13, 1910), a series of several Indian species with long-tubular corolla. Limpricht assigned it to the Oxycarpae (in Repert. Sp. Nov., 20: 247, 1924). To both of these it is but remotely related. The unique characteristics necessitate the erection for it of a special series.

SECTION XV. RHIZOPHYLLUM

Roots fascicled, mostly fleshy, much enlarged; stems usually low, many, clustered, and unbranched above; leaves mostly radical, many, long-petiolate, oblong to lanceolate, pinnatisect to sometimes pinnatifid, rarely crenate or subentire; flowers in long or short inflorescences; calyx cleft or not anteriorly, 5-dentate, the teeth equal to unequal, entire to serrate; corolla-tube equaling or longer than the calyx, straight or slightly bending; galea straight or slightly bending, the apex either subacute, entire, or bidentate, or beaked, the beak when present long-cylindric, straight or sigmoid; middle lobe of the lower lip smaller than the lateral, and more distad.

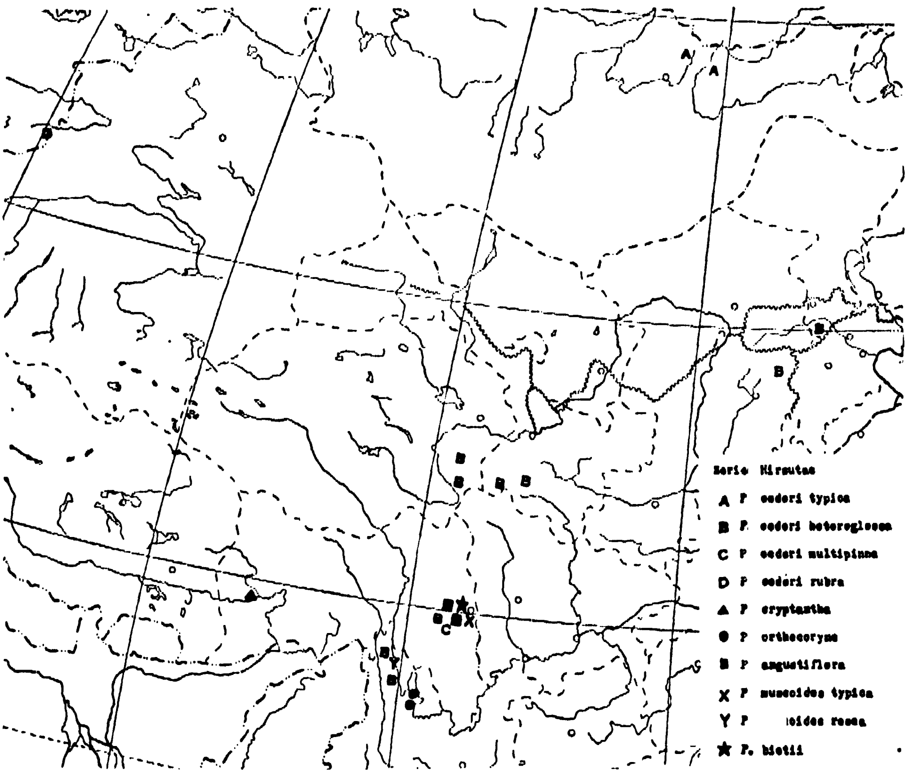
The species comprising this section all have mostly basal large leaves and a relatively short stem bearing few or no cauline leaves. The roots are fascicled, mostly fleshy and much enlarged. The range of the section extends from Europe through northern Asia to arctic North America, and also to the eastern Himalayas and western China.

Series 51. Hirsutae

Hirsutae Maxim., in Bull. Acad. St. Pétersb., 24: 86, 1878; in Mél. Biol., 10: 129, 1878.

Low or tall; roots fleshy, fascicled; stems clustered, usually unbranched above; leaves mostly radical, many, long-petiolate, oblong to lanceolate, pinnatisect or sometimes pinnatifid; flowers yellow or purple; calyx 5-dentate, the teeth subequal to unequal, triangular to oblong-ovate, entire to serrate; corolla-tube equaling or usually longer than the calyx, straight or slightly bent above; galea usually longer than the lower lip, straight or slightly bending, rounded or subacute at the apex, margins entire; lower lip 3-lobed, the lobes rounded, glabrous along the margins, the middle lobe often smaller and distad; staminal filaments all glabrous or sometimes hairy; capsules oblong-ovoid, slightly compressed, slightly obliquely acute.

Over 10 species in Europe, arctic and alpine Asia and Himalayas to arctic North America (Map 28).



Map 28.—Distribution of the series Hirsutae.

The common species of the series is *P. oederi* Vahl, more widely known by its later name *P. versicolor* Wahlenb. It occurs from Europe through

Asia to northern North America. Several varieties have been recognized for the Chinese forms of the species and also several related species have been described. In so far as the material warrants, a rearrangement of the group is now made, recognizing five species for the area covered.

Species of the series are readily recognized by their numerous basal leaves which are pinnatisect with numerous segments, their elongated calyx with usually an entire posterior tooth and serrate anterior teeth, and their edentate galea and rounded glabrous lobes of the lower corolla-lip with the middle lobe smaller and distinctly distad.

Key to the Chinese Species

A. Plants relatively tall, the stem 5-10 cm. or more high, the leaves large, over 3-4 cm. long; pinnae 15 or more on each side; calyx-teeth unequal, usually oblong-ovate and serrate except the posterior ones.

B. Corolla yellow, sometimes the galea purple or the lip spotted purple (except *P. oederi rubra* Maxim. with reddish corolla), the tube slightly longer than the calyx, the galea equaling or slightly longer than the lower lip.

C. Bracts lanceolate, about 1.5-2 cm. long and 1.5-2 mm. wide; corolla long, over 2 cm., the tube longer than the calyx, the galea long, slightly bending, rounded in front but truncate to slightly acute at the apex.

D. All staminal filaments glabrous; corolla-tube more or less straight throughout. .... 182. *P. oederi*

DD. Two of the staminal filaments glabrous and 2 hairy distally; corolla-tube straight below and slightly curved distally. 183. *P. cryptantha*

CC. Bracts broadly ovate, 1.5-2 cm. long, 6-8 mm. wide; corolla short, about 1.5-1.6 cm. long, the tube short, equaling the calyx, the galea short, straight, very rounded in front as well as at the apex. 184. *P. orthocoryne*

BB. Corolla purple, the tube over twice as long as the calyx; galea about twice as long as the lower lip, more or less acute at the apex. ... 185. *P. angustiflora*

AA. Plant low, the stem hardly 1-2 cm. high, the leaves small, about 1 cm. long; pinnae 8-10 on each side; calyx-teeth subequal, subentire to crenate.

B. Plant with stem to 1 cm. tall, the leaves oblong-lanceolate, pinnatisect; pedicels less than half as long as the calyx; calyx-teeth subentire; corolla rose or cream-colored, about 18-23 mm. long; anterior filaments hairy distally. 186. *P. muscoides*

BB. Plant with stem to 2 cm. tall, the leaves ovate, incised-crenate; pedicels as long as the calyx; calyx-teeth foliaceous, crenate; corolla rose, 25-30 mm. long; all filaments glabrous. .... 187. *P. bietii*

182. Pedicularis oederi Vahl

Prain divided the species into two varieties: var. *typica* being the typical form of the species widely distributed in arctic and alpine Europe, arctic and alpine Siberia, and arctic America, and according to Prain, also in the western Himalayas; and var. ***heteroglossa***, occurring in western and central Himalaya and mentioned also specifically by Prain in " N. Tibet, N. China, E. Kansu." The typical form thus occurs in China only in northern Mongolia, while the plant that is ordinarily recognized as *P. oederi* Vahl or more commonly by its well-known synonym, *P. versicolor* Wahlenb., which is widely distributed in western and northern China, is the var. *heteroglossa* of Prain. The plants occurring in northwestern Yunnan and Sikang agree fairly closely with those of Kansu and Shensi and probably should be included in the same variety. Prain, in differentiating the two varieties, stressed the character of the lower corolla-lip, which is larger in var. *heteroglossa* with a more projected middle lobe, and also the character of the calyx-teeth as mentioned below in the key. As to the color of the corolla, it seems that this varies from pure yellow to purple-tinted on the galea and purple-spotted on the lip, and lacks sufficient consistency for varietal differentiation. A large series of specimens from Europe, Siberia, various parts of the Himalayas, and China, is available for the present study. The characters of the two varieties of Prain present intermediates and are not so sharply differentiated as Prain thought.

Earlier, Maximowicz had made a similar differentiation (in Bull. Acad. St. Pétersb., 32: 618, 1888; in Mél. Biol., 12: 918, 1888). He distinguished the European plants from those of China on the same calyx-characters as used by Prain. In the illustrations he clearly depicted the former in fig. 177a, and the latter in fig. 177b. The first drawing of what he labelled " P. versicolor Wahlbg. Europaea " is evidently the same plant as *P. oederi typica* of Prain, and the second " P. versicolor sinensis " the same as *P. oederi heteroglossa* of Prain. It is evident from Maximowicz's text that these names were used adjectivally and not proposed as trinomials.

Key to the Varieties

A. Corolla yellow, sometimes the galea colored purple or the lower lip purple-spotted; calyx-teeth usually serrate to dentate distally, sometimes entire.
  B. Pinnae of leaves about 15-20 pairs.
    C. Calyx-teeth attenuate, entire to distally dentate; galea shorter than the tube; middle lobe of the lower corolla-lip not projecting. 182a. *P. o. typica*
    CC. Calyx-teeth mostly with spatulate dentate-lobulate tips; galea as long as the tube; middle lobe of the lower corolla-lip projecting. 182b. *P. o. heteroglossa*
  BB. Pinnae of leaves 25 to 30 pairs. .... 182c. *P. o. multipinna*
AA. Corolla dark red throughout; calyx oblong, the teeth entire. .. 182d. *P. o. rubra*

182a. **Pedicularis oederi** typica

Pedicularis oederi var. *typica* Prain, in Journ. As. Soc. Beng., 58 (2): 276, 1889; in Ann. Bot. Gard. Calcutta, 3: 181, pl. 34, A, 1890; Limpricht, in Repert. Sp. Nov., 20: 202, 1924. Prain originally cited for this: " Western Himalaya:—Kashmir, (Royle!); Tibet (Falconer!, Thomson!, Stoliczka!, Brandis!, Ellis!). Distrib.: Arctic and Alpine Europe; Arctic and Alpine Siberia; Arctic America."

Pedicularis oederi Vahl, in Hornem., Dansk. Oek. Plantel., ed II: 580, 1806. Vahl's type was from arctic Europe: " Den vorer paa Fjeldene i Norge men sjelden, f. Er. paa Bangsfjeldet i Opdalen, paa Devre imellen Fogstuen og Toste." Chinese plants referred to this and more commonly to its synonym *P. versicolor* Wahlenb. by various authors were, in most cases, actually the var. *heteroglossa* Prain. See that variety for citations.

Pedicularis versicolor Wahlenb., Veg. Helvet., 118, 1813; Maxim., in Bull. Acad. St. Pétersb., 24: 88, 1878, p.p.; 32: 618, p.p., fig. 177a, 1888; in Mél. Biol., 10: 133, 1878, p.p.; 12: 918, p.p., fig. 177a, 1888. Wahlenberg's type was from central Europe: "Hab. locis subuliginosis apricis in regione subalpina et alpina inferiore alpinum mediae altitudinis ubique frequentus; uti in Pilato et exinde per Schwander." Various authors have agreed that the Swiss form is conspecific with the Scandinavian. For a full discussion on the identity and application of the two names in question see Prain, in Ann. Bot. Gard. Calcutta, 3: 181-186, 1890.

Widely distributed through alpine and arctic Europe, northern Asia, and arctic North America. In China, in alpine meadows of northern Mongolia. Flowers yellow, often with purple galea or purple spots on the lip. Flowering from late June to early September.

Mongolia: Kentei orientales ad fontes fluviorum Kerulen et Onon, *Ikonnikov-Galitzky* 680 (NYBG); Montes Kentei ad fontes fluviorum Tola, Mensa et Iro, *Ikonnikov-Galitzky* 2723 (UC); Mongolia borealis, ad rivulum Sumein-gol, *Klementz* s.n. (ANSP, UCLA).

182b. **Pedicularis oederi heteroglossa** Prain Plate 8, fig. 148.

Pedicularis oederi var. *heteroglossa* Prain, in Journ. As. Soc. Beng., 58 (2): 276, 1889; in Ann. Bot. Gard. Calcutta, 3: 182, pl. 34, B-C, 1890; Limpricht, in Repert. Sp. Nov., 20: 203, 1924. Prain originally cited for this variety: "Western and Central Himalaya:—Kamaon (Royle!, Wallich!, Collett!, Duthie!, Reid!); Nepal (Scully!). Distrib.: N. Tibet, N. China, E. Kansu." For a consideration of the choice of the type for this variety see Pennell, Monogr. Acad. Nat. Sci. of Phila., 5: 141, 1943.

"*Pedicularis oederi*" *sensu* Marquand & Shaw, in Journ. Linn. Soc. Bot., 48: 213, 1929, *non P. oederi* Vahl *typica*.

"*Pedicularis versicolor*" *sensu* Maxim., in Bull. Acad. St. Pétersb., 24: 88, 1878, p.p.; 32: 618, p.p., fig. 177b, 1888; in Mél. Biol., 10: 133, 1878, p.p.; 12: 918, p.p., fig. 177b, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 219, 1890; Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 34, 1933; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 223, 1934; *non P. versicolor* Wahlenb. = *P. oederi typica*. The plants named as *P. oederi* or *P. versicolor* by various authors from most parts of China except northern Mongolia all belong to var. *heteroglossa* Prain and not to the typical form of the species.

From central Himalaya to Tibet, western and northern China. In moist alpine meadows, at altitudes of 3355 to 4420 meters. Flowers yellow, sometimes with purple-tipped galea. Flowering June and July.

Suiyuan: Hsiao Wutaishan, *T. P. Wang* 597 (NYBG), *Kung* 216 (RBGE).

Shensi: Mount Wutai, *Tang* 1140 (NYBG).

Kansu: T'ao River basin, Minshan Range, pass of Mt. Kuang Ke, *Rock* 12413 (ANSP, GH); T'ao River basin west of Adjuan, east end of Minshan, *Rock* 12601 (ANSP, GH, USNH), 12642 (ANSP, GH, NYBG); T'ao River basin, Shimen, Minshan Range, *Rock* 13124 (GH).

Chinghai: Radja and Yellow River gorges, road to Ugolok Country, *Rock* 13990 (ANSP, GH, USNH); between Radja and Jupar Range, *Rock* 14094 (ANSP, GH, NYBG), 14235 (ANSP, GH), 14395 (ANSP, GH, UC).

Sikang: Minya Konka Snow Range, south of Tatsienlu, *Rock* 17524 (ANSP, USNH).

Yunnan: no precise locality, *Forrest* s.n. (NTU), *Ward* s.n. (RBGE); Bei-mashan, *Forrest* 14023 (UCLA); Mekong-Yangtze divide, *Forrest* 19684 (ANSP); Mekong-Yangtze divide, southeast of Atuntze, *Rock* 22832 (NYBG, UC, UP).

Western China: no precise locality, *Wilson* 4231 (UCLA).

182c. **Pedicularis oederi multipinna** var. nov.

A typo speciei differt foliis lanceolatis, ad 4.5 cm. longis et 8 mm. latis, pinnis 25-30-jugis; labio galea paulo breviore, lobo medio porrecto.

Type, on grassy slopes at an altitude of 4150 meters in grasslands of Yulontsi, Minya Country, south of Tatsienlu, Sikang Province, collected in flower, July 1929, by J. F. Rock, No. 17479; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotype in the United States National Herbarium. Flowers yellow, the galea tipped with purple, the lower lip with purple spots. Only collection seen.

This variety is strikingly characterized by its narrower and relatively longer leaves with numerous pinnae. The floral structure resembles that of var. *heteroglossa*. In the numerously paired leaf-segments it resembles *P. branchiophylla* Pennell, a species recently described from the eastern Himalaya, but in the latter the segments are vertically disposed and broader.

182d. **Pedicularis oederi rubra** (Maximowicz) Limpricht

Pedicularis versicolor Wahlenb. var. *rubra* Maxim., in Bull. Acad. St. Pétersb., 32: 619, 1888; in Mél. Biol., 12: 918, 1888. Maximowicz's type was from the Russia-Sinkiang border: "Thianschan: montibus altissimis Chen-tengri (Krasnov, 1886)." It has not been seen.

Pedicularis oederi var. *rubra* (Maxim.) Limpricht, in Repert. Sp. Nov., 20: 202, 1924. This is a combination effected by Limpricht although he listed the author as Maximowicz only and did not indicate the combination.

In Tien Shan, Sinkiang border. Known from the original collection only.

No specimen seen.

As the original description mentions only the calyx-teeth and the corolla-color, the exact status of this plant is not ascertainable. It may be distinct from this species, since the other varieties have corolla yellow or only partly purplish.

183. **Pedicularis cryptantha** Marquand & Shaw

Pedicularis cryptantha Marquand & Shaw ex Marquand, in Journ. Linn. Soc. Bot., 48: 211, 1929. The type, "S. E. Tibet: On the grassy banks of streams, in woods, Tsela Dzong. 3400 m., May 29, 1924, F. Kingdon Ward 5711," has not been seen.

In western Sikang at an altitude of about 3400 meters. Flowers yellow. Flowering in late May. No specimen seen.

According to Marquand & Shaw this species is close to *P. oederi*, but differing in the corolla-tube being straight proximally and slightly curved distally, and in the staminal filaments being all glabrous.

184. **Pedicularis orthocoryne** nom. nov. Plate 8, fig. 149.

Pedicularis oederi var. *bracteosa* Bonati, in Notes Bot. Gard. Edinb., 8: 42, 1913; Limpricht, in Repert. Sp. Nov., 20: 203, 1924; Hand.-Maz., Symb. Sin., 7: 849, 1936. Bonati's type was from Yunnan: "'Alpine meadows on the eastern flank of the Lichiang Range. Lat. 27° 40′ N. Alt. 14,000-15,000 ft. June 1910.' G. Forrest. No. 6097." An isotype is in the Bonati Herbarium. This is the basis of the present species raised from Bonati's variety. The name "*bracteosa*" is preoccupied in *Pedicularis*.

"*Pedicularis angustiflora*" *sensu* Bonati, in Notes Bot. Gard. Edinb., 15: 147, 1926; Limpricht, in Repert. Sp. Nov., 23: 333, 1927; *non* Limpricht 1922. Bonati identified two Rock numbers, 4466 and 9418, as representing *P. angustiflora* Limpricht (*P. stenantha* Franch.) and was followed by Limpricht in his additional list to his enumeration, but these specimens do not represent his own species of 1922 and instead are identical with Bonati's own *P. oederi* var. *bracteosa* of 1913.

Plant low, about 5-6 cm. high, scarcely to 10 cm.; roots clustered, very thick; stem simple, puberulous; leaves cauline or radical, the radical leaves long-petiolate (petioles to 3.5 cm. long, slender, puberulous to glabrate), the blade about 2.2 cm. long and 8 mm. wide, ovate, pinnatisect to deeply pinnatifid, the segments 8-12-paired, oblong-ovate, about 3-4 mm. long and 2 mm. wide, acute, serrate, the radical leaves shorter-petiolate (petioles about 5 mm. long, hairy, winged), the blade like that of the radical leaves except that it is deeply pinnatifid rather than pinnatisect; inflorescence a raceme terminating the stem, about 2 cm. long, the bracts broadly ovate, foliaceous, prominent, about 1.5-2 cm. long, 6-8 mm. wide, distinctly crenate-serrate; pedicels 2-3 mm. long; calyx oblong, about 9 mm. long, glabrate proximally, pubescent distally and on the teeth, 5-ribbed, slightly reticulate distally, the teeth 5, unequal, the posterior one oblong-triangular and entire, the others ovate and serrate; corolla 1.5-1.6 cm. long, yellow throughout, glabrous, the tube about as long as the calyx, the galea straight, about 6-8 mm. long and 4 mm. wide, very rounded at apex, the lower lip about 5 mm. long, 3-lobed, the lobes rounded, the middle one smaller and very distad; stamens inserted near the base of the tube, the anther-pairs contiguous, the anterior filaments hairy distally, the posterior filaments glabrous; style included.

On grassy slopes at altitudes of 4420 to 4880 meters in northwestern Yunnan. Flowers pure yellow. Flowering from June to August.

YUNNAN: no precise locality, *Forrest* s.n. (UCLA); eastern flank of the Likiang Range, *Forrest* 6097 (ANSP); eastern slopes of the Likiang Snow Range, Mt. Satseto, *Rock* 24887 (CM, MBG, NYBG, UC, UP, USNH); eastern slopes of the Likiang Snow Range, Yangtze watershed, *Rock* 4466 (ANSP, UC, USNH), 9418 (USNH).

This species is very distinct, and for all reasons should be segregated from *P. oederi* and its varieties. The plant, compared with the latter species, is much lower, puberulous and less hairy. The leaf-blades are relatively shorter with about 12 or less pairs of pinnae. The calyx is almost glabrous below and hairy distally and on the teeth. The posterior calyx-tooth is oblong-triangular and entire, while the others are broadly ovate and serrate. The corolla is purely yellow throughout, the tube being almost equal to the calyx in length. The galea is wider, almost straight and very much rounded at the apex. The lower corolla-lip is 3-lobed with the middle lobe smaller than the laterals and very distad. The style is entirely included. All these characters depart from those of *P. oederi* and prove that it is specifically distinct from the latter.

185. Pedicularis angustiflora Limpricht Plate 8, fig. 150.

Pedicularis stenantha Franch., in Bull. Soc. Bot. France, 47: 36, 1901, *non* 1891. The types were from Sikang Province: "Chine occidentale, autour de Ta-tsien-lou (Pce

Henri d'Orléans); brousailles à Tche-to-chan, près de Tongolo (Soulié, n. 768)." These have not been seen.

Pedicularis angustiflora Limpricht, in Repert. Sp. Nov., 18: 244, 1922; 20: 203, 1924.[6] Limpricht proposed this name to replace *P. stenantha* Franch. of 1901, which is a different plant from one of the same name described by Franchet in 1891.

In alpine meadows at altitudes of 3960 to 5335 meters, in Sikang Province. Flowers purple. Flowering in June.

SIKANG: Mount Konka, Risonquemba, Konkaling, *Rock* 16293 (ANSP, USNH), 16375 p.p. (ANSP, USNH, p.p.).

These two numbers of Rock were collected near the original localities of the species. They agree fairly well with the original description of Franchet. The species is allied to *P. oederi*, being especially close to var. *heteroglossa*. It can be distinguished from the latter by its purely reddish purple corolla, its corolla-tube being 2 times as long as the calyx, and its galea being almost twice as long as the lower lip.

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186. **Pedicularis muscoides** sp. nov.

Key to the Varieties

A.	Corolla cream-colored, about 2.3 cm. long.	186a. *P. m. typica*
AA.	Corolla bright rose-colored, about 1.8 cm. long.	186b. *P. m. rosea*

186a. **Pedicularis muscoides** typica Plate 8, fig. 151.

Planta nana, inflorescentiis inclusis vix 4 cm. alta, foliis inflorescentiisque compactis; radicibus fasciculatis, valde crassis; foliis radicalibus longe petiolatis (petiolis gracilibus, 1-1.5 cm. longis, pubescentibus), oblongo-lanceolatis, circiter 1 cm. longis 2-3 mm. latis, glabris vel leviter pubescentibus, apice obtusis, pinnatisectis vel ad apicem profunde pinnatifidis, segmentis utrinsecus 8-10, ovatis, serratis; caulibus floriferis vix 1 cm. longis, 2-3-floris, bracteis foliaceis, oblongo-lanceolatis, circiter 1 cm. longis 2-3 mm. latis, superne pinnatifidis; pedicellis 2-3 mm. longis; calyce oblongo-ovoideo, circiter 8 mm. longo, 3-4 mm. lato, puberulo, 5-costato, superne leviter reticulato, 5-dentato, dentibus subaequalibus, oblongo-triangularibus, 2-2.5 mm. longis, subintegris; corollā pallidā, circiter 2.3 cm. longā: tubo recto, circiter 1.1 cm. longo; galeā subrectā, 1.2 cm. longā, 3-4 mm. latā, fronte rotundatā, apice acutā, margine integrā; labio inferiore circiter 9 mm. longo, 3-lobato, lobis rotundatis, integris, lobo medio subparvo, porrecto; filamentis ad basim tubi insertis, anterioribus apicem versus villosis, inferioribus glabris, antheris oblongis, loculis basi subacutis; stylo exserto; capsulis oblongo-ovoideis, leviter compressis, circiter 1.1 cm. longis 4 mm. latis, suboblique acutis.

Type, at altitudes of 3960 to 5335 meters, Mount Konka, Risonquemba, Konkaling, Sikang Province, collected in flower and fruit, June 1928, by J. F. Rock, No. 16343; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotype in the United States National Herbarium. Flowers cream-colored. Only collection seen.

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[6] Bonati, in Notes Bot. Gard. Edinb., 15: 147, 1926. Limpricht, in Repert. Sp. Nov., 23: 333, 1924, erroneously identified *Rock* 4466 and 9418 as *P. angustiflora* Limpricht; they are actually *P. oederi bracteosa* Bonati, treated in this paper as *P. orthocoryne*.

This very dwarf species is probably akin to *P. bietii* (vide description). However, the latter differs by the evident stem of 1-2 cm. long, by its ovate incised-crenate leaves, by its longer pedicels equaling the calyx in length, by its sparsely pilose calyx with foliaceous and crenate teeth, by its all glabrous filaments, and by its rose corolla, 25-30 mm. long and with a galea equaling the lower lip in length.

186b. **Pedicularis muscoides rosea** var. nov.

"*Pedicularis bietii*" *sensu* Limpricht, in Repert. Sp. Nov., 20: 199, 1924. p.p.; Staff Bot. Gard. Edinb., 17: 66, 1929; *non* Franch. *Forrest* 14411, erroneously credited to *P. bietii* by Limpricht, etc., is here used as the basis for this new variety.

A typo speciei differt corolla rosea, circiter 1.2 cm. longa.

Type, in boggy pastures at altitudes of 4270 to 4575 meters on the Bei-ma-shan, Lat. 28° 12′ N., northwestern Yunnan, collected in flower, July 1917, by G. Forrest, No. 14411; holotype in the Bonati Herbarium to be deposited in the herbarium of the University of California at Los Angeles; isotype in the herbarium of the Royal Botanic Garden, Edinburgh. Flowers bright rose.

YUNNAN: Bei-ma-shan, *Forrest* 14411 (RBGE, UCLA), no precise locality, *Forrest* 30447 (ANSP).

Except the color and smaller size of the corolla this variety shows all other characters of the species and is undoubtedly conspecific. Bonati indicated on the label that it differs from *P. bietii* in the 2 filaments being villose, although he considered it very near the latter.

187. **Pedicularis bietii** Franchet

Pedicularis bietii Franch., in Bull. Soc. Bot. France, 47: 34, 1900; Limpricht, in Repert. Sp. Nov., 20: 199, 1924, p.p.[7] Franchet's type, "Su-tchuen, autour de Ta-tsien-lou (Mussot, n. 294)," has not been seen.

In Sikang. Known from the original collection only. No specimen seen.

When Franchet first described this plant he indicated that it belonged to the "Anodontae-Sceptra," the form of the corolla and the arrangement of the flowers being near *P. capitata*. Limpricht included it in the series Gloriosae. Bonati (Gen. Pedic., 71, 1918) mentioned it in the series Capitatae. The species is strikingly characterized, according to the original description, by its short leaf-blade being ovate, hardly 1 cm. long and 5-6 mm. wide, incised-crenate with denticulate lobules. It seems that the species has not been clearly known to later authors. Type material is imperative for its clear understanding.

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[7] Limpricht, in addition to the type collection, listed also *Forrest* 14411. This same number was also identified by Bonati and listed by the Staff, Bot. Gard. Edinb., in Notes Bot. Gard. Edinb., 17: 66, 1929, as representing this species. However, this particular number is a different plant and is here treated in this paper under *P. muscoides rosea.*

Series 52. Rhynchodontae

Rhynchodontae Prain, in Hook. f., Icon. Plant., 23: pl. 2290, 1894.
Pseudo-oederianae Limpricht in Repert. Sp. Nov., 20: 217, 1924.

Low or tall plants, roots fascicled, fleshy; stems usually many, clustered, simple above; leaves mostly radical, numerous, some cauline, alternate, long-petiolate, usually oblong to lanceolate, pinnatisect to sometimes pinnatifid near the apex, the segments serrate; inflorescences terminating the stems, bracts foliaceous; calyx oblong, pubescent, 10-costate, usually slightly reticulate distally, 5-dentate, the teeth unequal, the posterior one smaller, oblong-triangular, entire to subentire, the others oblong-ovate to lanceolate, narrowed below, distinctly serrate distally; corolla purple or yellow proximally and purple on the galea, the tube slightly longer than the calyx, erect or slightly bending distally, the galea about as long as the tube, bending distally, the apex slightly projected, acute or tuncate, with one or more obscure or distinct teeth on the margins, the lower lip slightly shorter than the galea, 3-lobed, the lobes rounded, ciliate or glabrous on the margins, the middle one distad or not; staminal filaments glabrous or hairy.

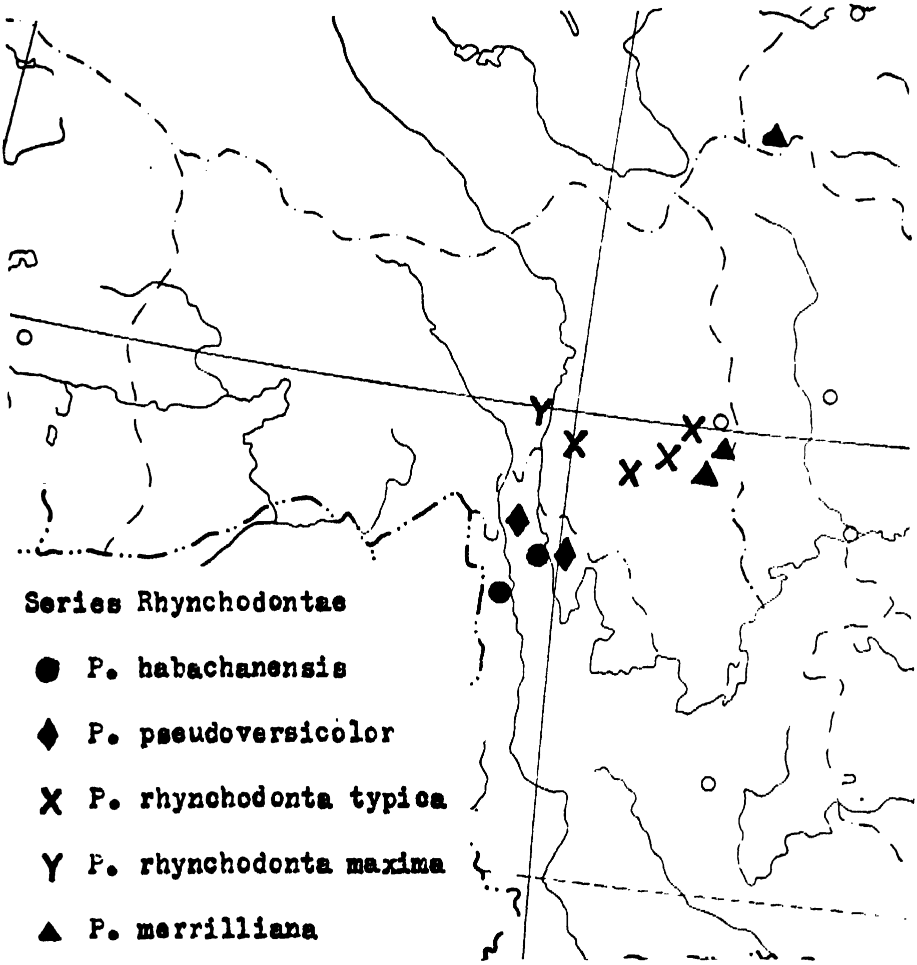
About 4 species in northwestern Yunnan, Sikang, and southwestern Kansu (Map 29).

Limpricht included two species, *Pedicularis rhynchodonta* and *P. pseudo-versicolor*, in his series *Pseudo-oederianae*, of which he gave no description. He apparently overlooked Prain's Rhynchodontae which is based on the former. *P. habachanensis*, originally included in the Sudeticae by Bonati, is very close to *P. pseudo-versicolor* and should be placed in the same series. The species of this series are very close to those of the series Hirsutae in both vegetative and floral characters. They can be distinguished from the latter by the presence of teeth on the galea.

Key to the Species

A. Galea with a more or less projected and acute apex, with one short, obtuse tooth on each margin, sometimes obscure; corolla purple, or yellow below and purple on the galea.
  B. Leaves pinnatisect, the segments 8-10-paired, corolla reddish purple throughout, the apex shorter; all 4 staminal filaments hairy, the two posterior ones being sparsely so; stigma long-exserted. .... 188. *P. habachanensis*
  BB. Leaves pinnatisect, the segments about 12-paired; corolla yellow with reddish galea, the apex more projected; only 2 anterior filaments hairy; stigma included or short-exserted. .... 189. *P. pseudo-versicolor*

AA. Galea with a short, broad beak-like apex, truncate, with one or more teeth on the margins, the teeth distinct, subulate; corolla purple throughout.
  B. Plant tall, 10-15 cm. high; leaves large, 8-10 cm. long; apex of galea provided with several teeth on each side, the lowest most distinct and longest; margins of the lower lip sparsely ciliate; 2 of the staminal filaments hairy. 190. *P. rhynchodonta*
  BB. Plant low, hardly 4 cm. high; leaves small, scarcely 3.5 cm. long; apex of galea provided with one distinct long tooth on each side; margins of the lower lip glabrous; all staminal filaments glabrous. ..... 191. *P. merrilliana*



Map 29.—Distribution of the series Rhynchodontae.

188. **Pedicularis habachanensis** Bonati Plate 8, fig. 152.

Pedicularis habachanensis Bonati, in Notes Bot. Gard. Edinb., 15: 151, 1926; Limpricht, in Repert. Sp. Nov., 23: 334, 1927. Bonati's type was from: "'Yunnan: Mount Habashan, north of Ndaku, north of the Likiang Snow Range, Yangtze drainage basin, 14,000 feet. Flowers reddish-purple. July 1923.' J. F. Rock No. 9683." Isotypes are in the herbaria of the Academy of Natural Sciences of Philadelphia, the Gray Herbarium, the University of California, and the New York Botanical Garden. Bonati's original description does not agree exactly with the available type specimen. He described the calyx-teeth as equal, but actually the posterior one is smaller and nearly entire while the others are lanceolate and acutely lobulate at the apex. The anterior one is sometimes also smaller than the others. The middle lobe of the lower corolla-lip is smaller than the lateral ones, and its margins are sparsely ciliate as Bonati described, but it is rather distad and the lateral lobes are also sparsely ciliate when young and only become glabrous when old. Bonati also described two of the staminal filaments as densely villose distally. In the available specimen all the filaments are found to be hairy, the anterior ones being more densely villose and the posterior ones less so and almost becoming glabrate in older flowers.

In alpine swampy meadows about 4100 to 4270 meters in northwestern Yunnan. Flowers reddish purple. Flowering in July.

YUNNAN: Mount Habashan, north of Ndaku, north of the Likiang Snow Range, Yangtse drainage basin, *Rock* 9683 (ANSP, GH, NYBG, UC); Salween-Kiukiang divide, Tsu-kuei, *Yü* 19347 (AA).

The teeth on the galea are rather small, obtuse and often obscure. To *P. cernua*, an opposite-leaved species, this and its kindred species are apparently related as shown by vegetative as well as floral characters.

189. Pedicularis pseudo-versicolor Handel-Mazzetti Plate 8, fig. 153.

Pedicularis pseudo-versicolor Hand.-Maz., in Anz. Akad. Wiss. Wien Math.-Nat. Kl., 57: 104, 1920; Symb. Sin., 7: 852, pl. 15, fig. 1-2, 1936; Limpricht, in Repert. Sp. Nov., 20: 217, 1924. The type, "Ibidem [Prov. Yunnan bor.-occid.] in glareosis [montis Picpun prope Dschungdien] 4300-4500 *m*. leg. 11 VIII. 1914," is *Handel-Mazzetti* 4705, as indicated by the author in a later redescription (l.c., 1936). It has not been seen.

Grassy slopes at altitudes of 3600-4650 meters in northwestern Yunnan. Flowers yellow with purplish galea. Flowering from June to August.

YUNNAN: no precise locality, *Forrest* s.n. (UCLA), *Yü* 8956 (AA), 12135 (AA); Bei-ma-shan, *Forrest* 19691 (ANSP); Atuntze, *C. W. Wang* 68981 (AA); Chungtien Plateau, *Feng* 1476 (AA).

This species has its flower colored like *P. oederi* and they are evidently related. The latter, however, has edentate galea. The teeth on the galea of *P. pseudo-versicolor* are short and obtuse and may be obscure or absent. In this character it is very close to *P. habachanensis* which resembles the present species in many other characters as well. *P. pseudo-versicolor* differs from *P. habachanensis* in the color of the flower being yellow with purplish galea instead of reddish purple throughout, in the galea-apex projecting more, in the styles being included or short-exserted instead of long-exserted, and in 2 rather than 4 filaments being hairy. The leaf-segments of *P. habachanensis* are 8-10-paired and broader, while those of *P. pseudo-versicolor* are about 12-paired and narrower.

190. Pedicularis rhychodonta Bureau & Franchet

Key to the Forms

A. Plant to about 1.5 dm. high, the leaves to about 8 cm. long including the petioles. 190a. *P. r. typica*

AA. Plant to about 3 dm. high, the leaves to about 18 cm. long including the petioles. 190b. *P. r. maxima*

190a. Pedicularis rhynchodonta typica Plate 8, fig. 154.

Pedicularis rhynchodonta Bur. & Franch., in Morot, Journ. de Bot., 5: 108, 1891; Prain, in Hook., Icon. Plant., 23: pl. 2209, 1894; Bonati, in Bull. Herb. Boiss., II, 7: 545, 1907; Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922; in Repert. Sp. Nov., 20:

217, 1924; Hand.-Maz., Symb. Sin., 7: 853, 1936. The type from Sikang, "province de Se-tchuen, sur les gazons secs entre Li-tang et Ta-tsien-lou [recueillie pendant le voyage de M. Bonvalot et du Prince Henri d'Orléans en 1890]," has not been seen.

In alpine meadows at altitudes of 3660 to 4700 meters in Sikang. Flowers purple to purplish pink. Flowering in May and June.

SIKANG: Ta-tsien-lou, *Soulié* 1003 (ANSP, UCLA); Mount Mitzugo west of Muli Gomba, *Rock* 16196 (ANSP, USNH); Mount Konka, Risenquemba, Konkaling, *Rock* 16307 (ANSP, USNH); Djesi-La and Djesi-Longba, south of Tatsienlu, *Rock* 17729 (ANSP, USNH); Mount Siga, northwest of Kulu, *Rock* 17898 (ANSP, USNH); Mountains of Yetsi, north of Kulu, Muli Territory, *Rock* 23907 (CM, MBG, NYBH, UC, USNH); Baurong to Tachienlu via Hadjaha, *Stevens* 525 (CM).

This species is associated with *P. habachanensis*, *P. angustiflora*, etc., but is distinctly characterized by its shortly rostrate galea, the short beak being truncate, many-toothed, with the lower tooth on each side longer than the others. In some flowers, however, the teeth are not very distinct. Bureau and Franchet described the calyx-teeth as short, the 4 lateral ones being triangular and cristate at apex and the posterior one smaller and entire. In the different specimens here studied the posterior tooth is triangular and entire while the others are oblong to lanceolate and serrate distally.

190b. **Pedicularis rhychodonta** f. **maxima** Bonati

Pedicularis rhynchodonta f. *maxima* Bonati, in Bull. Soc. Bot. France, 55: 313, 1908; Limpricht, in Repert. Sp. Nov., 20: 217, 1924. The type, "Récoltés à Zambala par le R. P. Soulié," has not been seen.

Sikang. Known from the original collection only. No specimen seen.

According to Bonati this form has the flowers about the same size as that of the typical form of the species, but is much larger in its vegetative parts with the stem attaining to a height of 30 cm. and the leaves to 18 cm. in length.

191. **Pedicularis merrilliana** sp. nov. Plate 8, fig. 155.

Planta nana, inflorescentiis inclusis vix 5 cm. alta; radicibus fasciculatis, crassis; caulibus pluribus, 1-2 cm. longis, simplicibus, pubescentibus; foliis alternis, plerumque radicalibus, longe petiolatis (petiolis gracilibus, 1-2.5 cm. longis, glabris), oblongis, obtusis, 1-1.5 cm. longis, 4-7 mm. latis, glabris, pinnatisectis, segmentis utrinsecus 8-12, oblongis, obtusis, 1 mm. latis, serratis; inflorescentiis cauli terminalibus, circiter 3-floris; bracteis foliaceis, lanceolatis, 0.8-1.5 cm. longis, 3-4 mm. latis, superne pinnatifidis vel pinnatisectis; pedicellis 2-4 mm. longis, pubescentibus; calyce oblongo, circiter 1 cm. longo 3 mm. lato, puberulo, 10-costato, superne paulo reticulato, 5-dentato, dentibus inaequalibus, dente posteriore oblongo-triangulari, subintegro, caeteris oblongo-ovatis, inferne angustis, superne serratis; corollā purpureā, circiter 2.2 cm. longā: tubo circiter 1.1 cm. longo, erecto; galeā tubum aequante, curvatā, fronte rotundatā, apice leviter productā, truncatā, margine bidentatā, dentibus distinctis, subulatis; labio circiter 7 mm. longo, profunde 3-lobato, lobis rotundatis, margine glabris, lobo medio subaequali, leviter porrecto; staminibus ad basim tubi insertis; stylo exserto; capsulis oblongo-ovoideis, circiter 1.1 cm. longis, 4 mm. latis, leviter compressis, suboblique acutis.

Type, in alpine meadows at an altitude of about 4900 meters in Djesi-La and Djesi-Longba, south of Tatsienlu (Kanting), Sikang, collected in flower, June-July, 1929, by J. F. Rock, No. 17707; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotype in the United States National Herbarium.

In alpine meadows at altitudes of 3250 to 4900 meters in Sikang and southwestern Kansu. Flowers purple. Flowering in June and July.

KANSU: south of Mt. Konkei, Minshan Range, *Rock* 12529 (ANSP, GH, NYBG).

SIKANG: Djesi-La and Djesi-Longba, south of Tatsienlu, *Rock* 17707 (ANSP, USNH); north of Chiu-lung Hsien in Minya Country southwest of Tatsienlu, *Rock* 17454 (USNH).

This species resembles *P. bietii,* the latter being known from the description only. It is a similar low plant but differs from the latter by its stem, pedicel, and calyx being more hairy, by its longer leaves, and by its corolla only 22 mm. long and with distinctly bidentate galea. In *P. bietii* the corolla is 25-30 mm. long and edentate.

This species is named in honor of Dr. E. D. Merrill, Director of the Arnold Arboretum and Administrator of Botanical Collections of Harvard University—a leading authority on the flora of eastern Asia.

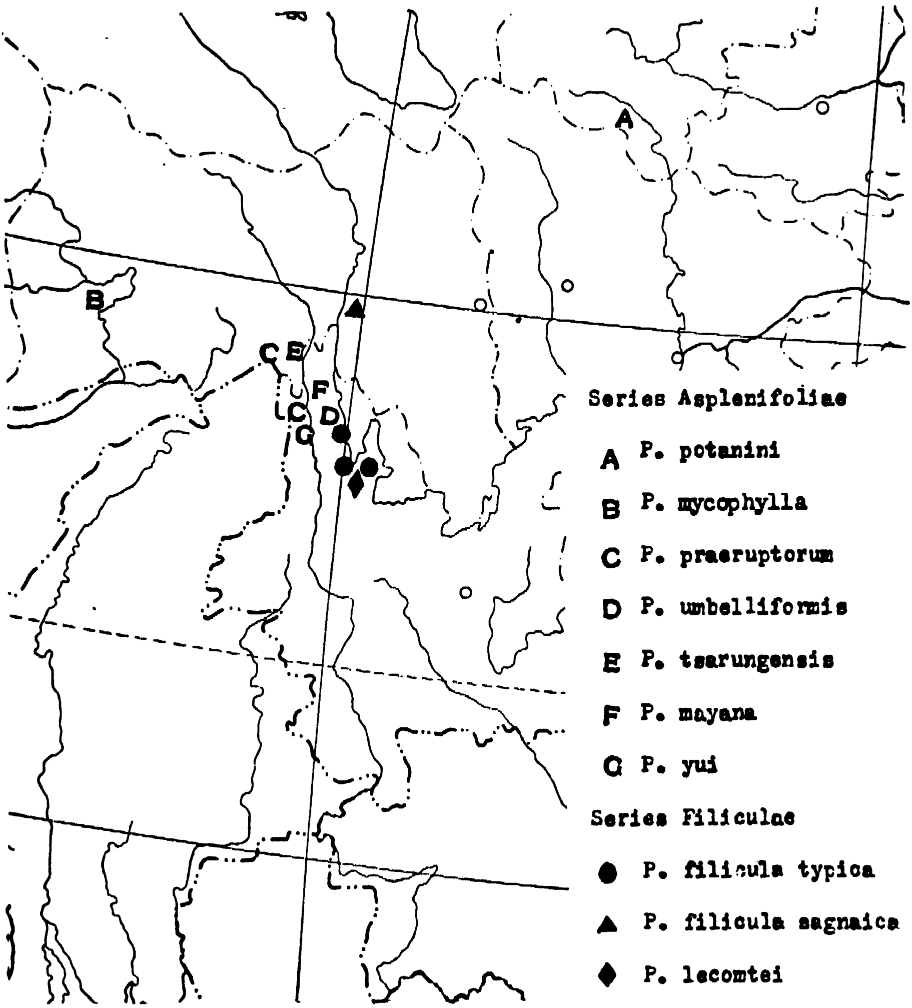
Series 53. Asplenifoliae

Asplenifoliae Prain, in Ann. Bot. Gard. Calcutta, 3: 79, 1890, p.p.

Low plants, glabrate to pubescent; roots thickened, clustered; stems erect, single or usually several together; leaves almost wholly radical, usually many, elongate to lanceolate, long-petiolate, pinnatisect, the segments 5-7 on each side, ovate to oblong or lanceolate, dentate to pinnatifid; cauline leaves usually none; inflorescences short, few-flowered; pedicels distinct; bracts foliaceous; calyx cylindric, not cleft anteriorly, unequally 5-dentate, the teeth rounded to lanceolate, dentate; corolla white, yellow or purple, the tube longer than the calyx, erect, straight or slightly bending distally, the galea glabrous or slightly glandulose-hairy, slightly cristate or not, the apex produced into a long cylindric-conical beak, the lower lip glabrous or ciliate on the margins, 3-lobed, the lobes rounded, the middle smaller, slightly distad; staminal filaments glabrous or rarely hairy.

About 9 species from the Mediterranean region to Tibet, eastern Himalaya, eastward to arctic North America (Map 30).

This series is closely related to the series Paucifoliatae with similar. habit and floral structures. The species differ from those of the latter in that the stems are wholly or practically leafless, the leaves being all radical and usually very numerous. In the Paucifoliatae the radical leaves are few and there are a few cauline leaves almost equal to the radical ones in size.



Map 30.—Distribution of the series Asplenifoliae and Filiculac.

Key to the Chinese Species

A. Leaves ovate, the segments 3-5 on each side, ovate, dentate; calyx-teeth short, rounded or obtuse, deeply dentate; corolla whitish yellow; all 4 staminal filaments hairy, the anterior ones more densely so. .... 192. *P. potanini*

AA. Leaves oblong to lanceolate, the segments 5-7 on each side, lanceolate, dentate to pinnatifid; calyx-teeth oblong to lanceolate, crenulate-dentate to incised-lobed; corolla rose or purple to yellow proximally and purple distally; filaments all glabrous or only 2 hairy.

B. Calyx-teeth short, obtuse or emarginate; pedicels to about 2 cm. long. 193. *P. mychophylla*

BB. Calyx-teeth oblong to lanceolate, crenulate-dentate to incised-dentate; pedicels 4-8 m. long.

C. Lower lip of the corolla ciliate on the margins.
  D. Plant 5-8 cm. tall; calyx-teeth unequal, the posterior subentire, the others dentate. .... 194. *P. praeruptorum*
  DD. Plant to 10-15 or more cm. tall; calyx-teeth subequal, all dentate.
    E. Plant lower, to 13 cm. tall; leaves smaller, the blade 2.2 cm. long; inflorescences subumbellate; anterior filaments sparsely hairy. .... 195. *P. umbelliformis*
    EE. Plant taller, to 22 cm. tall; leaves larger, the blade to 3 cm. long; inflorescences 2-3 cm. long; all filaments glabrous. 196. *P. tsarungensis*

CC. Lower lip of the corolla glabrous on the margins.
  D. Plant more or less hairy; calyx hairy, the teeth narrow, crenulate-dentate; corolla-tube slightly bending distally, the galea slightly cristate; anthers oblong. .... 197. *P. mayana*
  DD. Plant glabrate; calyx glabrous, the teeth broad, incised-dentate; corolla-tube straight, the galea not cristate; anthers ovoid. 198. *P. yui*

192. **Pedicularis potanini** Maximowicz

Pedicularis potanini Maxim., in Bull. Acad. St. Pétersb., 32: 570, fig. 68, 1888; in Mél. Biol., 12: 848, fig. 68, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 214, 1890; Limpricht, in Repert. Sp. Nov., 20: 236, 1924. The type was from "Kansu orientali, sylva ad latus septentrionale montis Tschagola, prope pagum Terjga (Potanin, 1885)." It has not been seen.

In southern Kansu. Flowers whitish yellow. Known from the original collection only. No specimen seen.

193. **Pedicularis mychophila** Marquand & Shaw

Pedicularis mychophila Marquand & Shaw ex Marquand, in Journ. Linn. Soc. Bot., 48: 212, 1929. The type, "S. E. Tibet: In crevices and on ledges of the gneiss cliffs. Nam. La, 4200-4500 m., July 25, 1924, *F. Kingdon Ward* 6043," has not been seen.

Sikang. Flowers purplish red. Flowering in July. Known from the original collection only. No specimen seen.

This species was originally indicated as related to *P. aphyllocaulis*. The proper position of the species, in view of the efoliolate stem as described, is evidently in the Asplenifoliae. By its small-sized, few-flowered, short inflorescences and its 4 glabrous staminal filaments, this species is clearly closely related to *P. mayana* and *P. praeruptorum*. Its most distinct character, as described, is the long pedicel.

194. **Pedicularis praeruptorum** Bonati Plate 8, fig. 156.

Pedicularis praeruptorum Bonati, in Notes Bot. Gard. Edinb., 13: 126, 1921; Limpricht, in Repert. Sp. Nov., 20: 236, 1924. The type, "'S. E. Tibet:—on precipices, alpine turf, etc., at Ka-gwr-pw. Alt. 15,500 ft. July 1913.' F. Kingdon Ward. No. 812," has not been seen. This locality is in Tsarung, Sikang Province.

Alpine meadows at altitudes of about 3700 to 4000 meters in Sikang and northwestern Yunnan. Flowers purple. Flowering in July and August.

YUNNAN: Upper Kiukiang Valley (Clulung), south of Lungtsahmuru, *Yü* 19863 (AA).

Although Bonati originally included this species in the series Paucifoliatae he compared it only with *P. filicula* and *P. potanini* both of the

series Asplenifoliae. According to his description this species is closely akin to *P. mayana* and *P. mychophila*. The above cited specimen agrees closely with the original description.

195. **Pedicularis umbelliformis** sp. nov. Plate 9, fig. 157.

Planta 10-13 cm. alta; radicibus filiformibus gracilibus; caulibus singulis, efoliatis vel raro 1-foliatis, sparse pubescentibus, basi squamis membranaceis lanceolatis tectis; foliis radicalibus, ovato-oblongis, longe petiolatis, ad 4.5 cm. longis, petiolis ad 2.5 cm. longis, gracilibus, villosis, laminis circiter 1.5-2.2 cm. longis, 7-8 mm. latis, membranaceis, glabratis vel sparse villosis, pinnatisectis vel profunde pinnatifidis, segmentis utrinsecus 6-7, approximatis, ovatis, obtusis vel rotundatis, pinnatifidis et dentatis; foliis caulinis nullis vel raro singulis, breviore petiolatis; inflorescentiis terminalibus subumbellatis, 6-8-floris; floribus breviter pedicellatis; pedicellis vix 2-3 mm. longis; bracteis foliaceis, breviter petiolatis, calycem subaequantibus, pinnatifidis, villosis; calyce cylindrico, circiter 6 mm. longo, sparse villoso, haud reticulato, 5-dentato, dentibus subaequalibus, stipitatis, superne dentatis, sparse villosis; corollā rubro-purpureā (?) circiter 1.6 cm. longā: tubo cylindrico, calycem duplo superante, superne paulo dilatato; galeā rectangulatim curvatā, in parte verticali erectā tubum ½ longiore, in parte horizontali 3-4 mm. longā, haud cristatā, in rostrum productā; rostro 3-4 mm. longo, conico-filiformi, recto vel subcurvato; labio inferiore superius subaequante, margine sparse ciliato, leviter trilobato, lobis subaequalibus, lobo medio sub-porrecto; staminibus ad medium tubi insertis, filamentis anterioribus superne parce villosis, inferioribus glabris; capsulis ignotis.

Type, in northwestern Yunnan (field data not available), collected in flower, by T. T. Yü, No. 11746; holotype in the herbarium of the Arnold Arboretum. Only collection seen.

This species is related to *P. praeruptorum* and *P. tsarungensis*. However, it is distinctly characterized by the subumbellate inflorescences, and the sparsely hairy anterior filaments. The corolla-color, as apparent in the dry state, is evidently reddish purple.

196. **Pedicularis tsarungensis** sp. nov. Plate 9, fig. 158.

Planta 9-22 cm. alta, radicibus fasciculatis, filiformibus gracilibus; caulibus solitaribus vel multis, efoliatis vel subnullis, sparse lanato-villosis, basi squamis membranaceis lanceolatis tectis; foliis radicalibus ovato-oblongis longe petiolatis, 6-9 cm. longis; petiolis 2-5 cm. longis, gracilibus, sparse villosis; laminis circiter 2-3 cm. longis, 1-1.2 cm. latis, utrinque villosis, pinnatisectis vel profunde pinnatifidis, segmentis utrinsecus 6-7, remotis, oblongo-ovatis vel oblongis, obtusis, pinnatifidis et dentatis; foliis caulinis nullis vel raro singulis, breviore petiolatis; inflorescentiis 2-3 cm. longis, 6-8-floris, floribus superioribus plus minusve aggregatis; bracteis foliaceis, breviter petiolatis, profunde pinnatifidis, utrinque villosis; calyce cylindrico, sparse villoso, haud reticulato, 5-dentato, dentibus subaequalibus inferne stipitatis, superne latis foliaceis incisis villosis; corollā rubropurpureā, circiter 1.8 cm. longā: tubo cylindrico recto summo paulo dilatato, calycem superante, circiter 1.2 cm. longo; galeā rectangulatim curvatā, in

parte verticali erectā tubum ½ longiore, in parte horizontali 3-4 mm. longā, non cristatā, in rostrum rectum paulo declinatum 4-5 mm. longum cito lente attenuatā; labio inferiore superius aequante margine sparse ciliato leviter trilobato, lobis orbicularibus subaequalibus; staminibus ad medium tubi insertis; filamentis omnibus glabris; capsulis ignotis.

Type, at an altitude of about 4000 meters in alpine meadows in regions of the Sola-la, Tsarung, Sikang province, collected in flower, May-June, 1932, by J. F. Rock, No. 22261; holotype in the herbarium of the New York Botanical Garden; isotypes in the herbaria of the Chicago Natural History Museum, the Missouri Botanical Garden, University of California, University of Pennsylvania, and in the United States National Herbarium.

Alpine meadows at an altitude of about 4000 meters in Sikang. Flowers purplish red. Flowering in May and June.

SIKANG: Tsarung, *J. F. Rock* 22261 (CM, MBG, NYBG, UC, UP, USNH), 22688 p.p. (UC).[8]

This species is apparently related to *P. praeruptorum* especially in the 4 glabrous filaments. From this and its allies it is distinguished by its large size. From *P. praeruptorum*, which it resembles in the ciliate-margined lower corolla-lip, it may be further distinguished by its larger corolla and subequal wholly dentate calyx-teeth.

197. **Pedicularis mayana** Handel-Mazzetti Plate 9, fig. 159.

Pedicularis mayana Hand.-Maz., Symb. Sin., 7: 858, pl. 15, fig. 10, 1936. The type, "NW. Y[unnan]: Matten auf Kalk in der [Hochgebirgs-(alpine) Stufe] des birm. Mons. [Nordost-birmanisch—west-yünnanesisches Monsungebiet] am Hange des Maya gegen den Schöndsu-la in der Mekong-Salwin-Kette, 28° 4′, 4300-4575 m, 3. VIII, 1916 (9641)." has not been seen.

In alpine meadows at altitudes of about 3660 to 4500 meters in northwestern Yunnan. Flowers purple. Flowering from May to August.

YUNNAN: Fuchuan Range, southwest of Wei-si, Mekong-Salween divide, *Rock* 17036 (ANSP, USNH), 22722 (NYBG, UC, UP, USNH); Che-tse-lo, top of Pi-lo-shan, *Tsai* 58201 (AA).

A rather dwarf species only 4-9 cm. tall with thickened roots and dense clusters of radical leaves, together with numerous membranaceous brown lanceolate scales. The stems are many, efoliolate, and bearing subcapitate inflorescences at the apex. The galea is minutely rubescent-glandulose above, and is slightly cristate. The latter character, however, was not mentioned in Handel-Mazzetti's original description. The species is further characterized by the staminal filaments being all glabrous.

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[8] This number consists of two elements, a single flowering specimen which belongs to this species and several fruiting specimens which are apparently *P. tsekouensis*. It is possible that the flowering specimen is actually of the same collection of *Rock* 22261 as it bears the same original field label in Chinese, apparently made by one of Rock's native collectors, reading "No. 368, Sola-la Mountains, red flowers"; the same label appears also on the University of California sheet of *Rock* 22261.

198. Pedicularis yui sp. nov. Plate 9, fig. 160.

Planta nana, 6-7 cm. alta; radicibus singulis vel multis, filiformibus, gracilibus; caulibus solitaribus simplicibus efoliatis glabris, basi squamis membranaceis lanceolatis obtusis tectis; foliis radicalibus ovato-oblongis longe petiolatis, 2-3 cm. longis; petiolis 1.5-2 cm. longis gracilibus glabris; laminis circiter 1 cm. longis 3-4 mm. latis, utrinque glabratis, pinnatisectis, segmentis utrinsecus 4 vel 5, ovatis obtusis, pinnatilobulatis; inflorescentiis 4-6-floris, floribus plus minusve aggregatis; bracteis foliis radicalibus similibus, petiolatis pinnatisectis; pedicellis erectis filiformibus, ad 4-6 interdum ad 10 mm. longis; calyce cylindrico circiter 8 mm. longo, glabro, dentibus exceptis haud reticulato, 5-dentato, dentibus subaequalibus, foliaceis, plus minusve incisis; corollā purpureā, circiter 1.8 cm. longā; tubo cylindrico recto, summo paulo dilatato, calycem superante; galeā rectangulatim curvatā, in parte verticali erectā tubum ½ longiore, in parte horizontali 3-4 mm. longā, non cristatā, in rostrum rectum plus minusve obliquum circiter 4-5 mm. longum cito attenuatā; labio inferiore superius aequante margine glabro breviter trilobato, lobis orbicularibus subaequalibus; staminibus ad medium tubi insertis, filamentis omnibus glabris; capsulis ignotis.

Type, in alpine swamp at an altitude of 4100 meters, Tsukuei, Salween-Kiukiang divide, Yunnan, collected in flower, July 14, 1938, by T. T. Yü, No. 19382; holotype in the herbarium of the Arnold Arboretum. Flowers purplish pink. Only collection seen.

A dwarf species very closely resembling *P. mayana*. From the latter it differs especially in the glabrate habit with glabrous calyx and its broad distinctly incised-dentate teeth, and in the straight corolla-tube. *Pedicularis mayana* has a much more thickened root with many heads and stems crowning its top. In this new species the roots are slender and the stem single. Both species bear many membranaceous, linear-lanceolate scales at the base of the stems, these apparently being transformed bases of petioles.

Series 54. Filiculae ser. nov.

Low or medium-sized plants, glabrate to pubescent; roots thickened, fascicled, clustered; stems erect, fleshy, single or several together; leaves mostly radical, many, lanceolate, long-petiolate, pinnatisect, the segments oblong to lanceolate, pinnatifid, 10-15 on each side; cauline leaves usually none; inflorescences elongated, many-flowered; pedicels distinct; bracts foliaceous; calyx cylindric, not cleft anteriorly, the teeth 5, unequal, deeply incised-lobed; corolla purple or yellow and with purple beak, the tube longer than the calyx, erect, straight or slightly bending distally, the galea glabrous, falcate, the apex produced into a long conical beak, the lower lip glabrous or ciliate on the margins, 3-lobed, the lobes rounded, the middle smaller, slightly distad; anterior filaments hairy or rarely glabrous.

Two species in northwestern Yunnan and southern Sikang (Map 30).

These two species are separated from the series Asplenifoliae. They differ from it in the more fleshy stems, the longer, narrower leaves with

more numerous segments, and the longer and more numerously flowered inflorescences.

Key to the Species

A. Corolla rose or purple, about 20-25 mm. long, the tube slightly bending distally, the lower lip ciliate on the margins. .... 199. *P. filicula*

AA. Corolla yellow with purple beak, about 30-35 mm. long, the tube straight, the lower lip glabrous on the margins. .... 200. *P. lecomtei*

199. **Pedicularis filicula** Franchet

Key to the Varieties

A. Beak longer, about 3-4 mm. long; median lobe of the lower lip smaller than the lateral ones; anterior filaments sparsely hairy. .... 199a. *P. f. typica*

AA. Beak slightly shorter; median lobe of the lower lip larger than the lateral ones; all filaments glabrous. .... 199b. *P. f. saganaica*

199a. **Pedicularis filicula** typica Plate 9, fig. 161.

Pedicularis filicula Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 573, fig. 74, 1888; in Mél. Biol., 12: 853, fig. 74, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 209, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 86, 1911; 7: 129, 1921; 8: 41, 1913; 15: 159, 1926; Limpricht, in Repert. Sp. Nov., 20: 235, 1924; 23: 336, 1927; Hand.-Maz., Symb. Sin., 7: 858, 1936. The type, "Yunnan, pratis alte alpinis prope glaciem Li-kiang (Delavay! in herb. Paris)," has not been seen.

Alpine meadows at altitudes of 2800 to 4880 meters in northwestern Yunnan. Flowers deep rose to purple. Flowering from May to July.

YUNNAN: no data, *Forrest* 28558 (ANSP), 28562 (ANSP), *Yü* 6193 (AA), 6515 (AA); eastern slopes of Likiang Snow Range, *Forrest* 2420 (ANSP, NTU, UCLA), *Rock* 3758 (USNH), 3972 (USNH), 4366 (NYBG, USNH), 4666 (USNH), 4992 (USNH), 5010 (NYBG, USNH), 8655 (ANSP, UC, USNH); eastern slopes of Mount Dyinaloko, northern peak of the Likiang Snow Range, *Rock* 9024 (GH, USNH), Likiang, *C. W. Wang* 71674 (AA); Likiang Snow Range, *Yü* 15440 (AA), *Ching* 30326 (AA).

Some of the specimens bear fruiting stalks apparently of last year's growth. The capsule is erect, oblong, acuminate, about 1.2 cm. long and 5 mm. wide, scarcely compressed, on a long slender pedicel of about 1 cm. long and enclosed by the calyx at the lower one-third.

In all its characters combined this species is closely akin to *P. pseudoversicolor* and its relatives, particularly in the fleshy fascicled roots, large pinnate radical leaves, etc. It is clearly derived from certain species of the series Hirsutae and Rhynchodontae by the development of a terminal beak on the galea of the corolla.

199b. **Pedicularis filicula saganaica** Handel-Mazzetti

Pedicularis filicula Franch. var. *saganaica* Hand.-Maz., Symb. Sin., 7: 858, 1936. The type was from "S[zechuan]: Humöse Stellen auf dem Gipfel Saganai ober Muli, Kalk, 4475-4525 m, 30. VII. 1915 (7341)." It has not been seen.

In southeastern Sikang. Known from the original collection only. No specimen seen.

200. Pedicularis lecomtei Bonati Plate 9, fig. 162.

Pedicularis lecomtei Bonati, in Bull. Soc. Bot. France, 55: 543, 1908; Limpricht, in Repert. Sp. Nov., 20: 235, 1924. The type was from "Yunnan (*R. P. Delavay*)." This is *Delavay* 3755, of July 9, 1889, from "Macul chan, Hokin," in Yunnan Province. Three duplicate sheets (ex Herb. Mus. Paris) are in the Bonati Herbarium.

Rocky slopes at an altitude of about 3500 meters in northwestern Yunnan. Flowers yellow with the beak violet. Flowering in July. Known from the original collection only.

YUNNAN: Hokin, Macul-chan, *Delavay* 3755 (ANSP, NTU, UCLA).

This species is closely akin to *P. filicula,* differing from the latter only in the corolla being yellow with purple beak, much longer with a longer tube and a longer galea, the latter straight and erect proximally, and in the lower lip being glabrous on the margins.

Series 55. Paucifoliatae

Paucifoliatae Prain, in Ann. Bot. Gard. Calcutta, 3: 80, 1890.

Low or medium-sized plants, glabrate to pubescent; stems single or several together; leaves radical or cauline, the radicals few, long-petiolate, the cauline same as the radicals, oblong-lanceolate, pinnatifid, the lobes obtuse, serrate; calyx slightly cleft anteriorly or not, 5-dentate, the teeth subequal to unequal, all dentate, or the posterior entire and the others dentate; corolla rose or purple to reddish, the tube erect, as long as or longer than the calyx, the galea erect proximally, bending distally, prolonged into a long slender beak, the lower lip 3-lobed, the lobes glabrous or ciliate on the margins, the median lobe slightly smaller; 2 or all 4 of the staminal filaments hairy.

About 9 species in the eastern Himalayas, upper Burma, and northwestern Yunnan (Map 31).

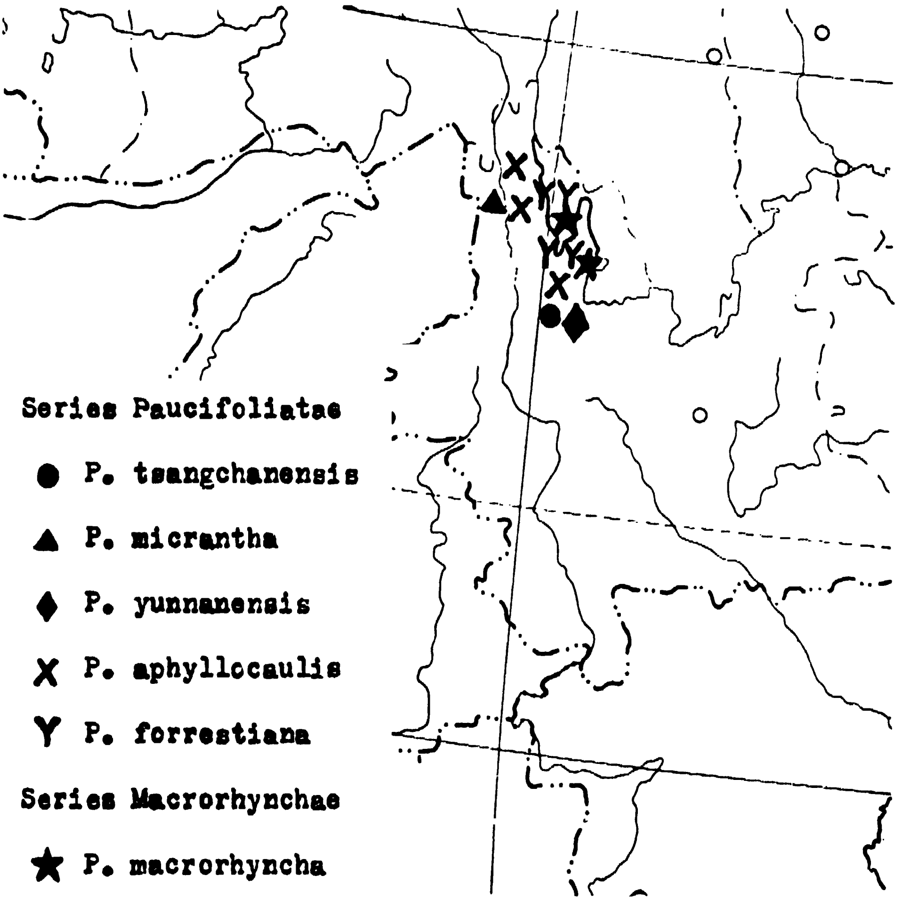
This series is very close to the series Asplenifoliae. It differs chiefly in the presence of a few cauline leaves while the stem of Asplenifoliae is often efoliate. The leaves of the species of Asplenifoliae are mostly pinnatisect while those of the species of the Paucifoliatae are pinnatifid. The beak in the Asplenifoliae is slightly shorter and more conical while in the Paucifoliatae it is longer and more slender.

Key to the Chinese Species

A. Plants more or less densely hairy on both stems and leaves; lower lip of corolla glabrous on the margins; 2 of the staminal filaments hairy. 201. *P. tsangchanensis*

AA. Plants glabrous or slightly pubescent; lower lip of corolla ciliate on the margins; all 4 staminal filaments hairy.

  B. Plant glabrous; leaves membranaceous, large, 6-7.5 cm. long and 2-2.7 cm. wide, with 6-8 lobes on each side; flowers small, about 1-1.2 cm. long; calyx-teeth short, as long as broad, 3-dentate; 2 of the staminal filaments hairy. 202. *P. micrantha*



Map 31.—Distribution of the series Paucifoliatae and Macrorhynchae.

BB. Plants slightly pubescent; leaves more chartaceous, smaller, to 4 cm. long and 2 cm. wide; flowers larger, about 1.5 cm. or more long; calyx-teeth long, narrow, serrate; all 4 staminal filaments hairy.

- C. Stems with few (1 or 2) cauline leaves; calyx slightly cleft anteriorly, the teeth oblong to lanceolate, unequal, the posterior entire, the others serrate.
  - D. Leaves shorter and broader, about 2 times as long as wide, the lobes about 6-10 on each side. .... 203. *P. yunnanensis*
  - DD. Leaves longer and narrower, about 4-6 times as long as wide, the lobes about 8-16 on each side. .... 204. *P. aphyllocaulis*
- CC. Stems more leafy; calyx not cleft anteriorly, the teeth short and flabellate, equal and all dentate. .... 205. *P. forrestiana*

201. Pedicularis tsangchanensis Franchet Plate 9, fig. 163.

Pedicularis tsangchanensis Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 571, fig. 69, 1888; in Mél. Biol., 12: 850, fig. 69, 1888; Forbes & Hemsl., in Journ. Linn. Soc.

Bot., 26: 218, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 86, 1911; 7: 242, 1921; Limpricht, in Repert. Sp. Nov., 20: 236, 1924. The type was from: "Yunnan, in humidis montis Tsang-chan supra Tali, 4000 m.s.m. (Delavay! in herb. Paris)." It has not been seen.

At an altitude of 4000 meters, in northwestern Yunnan. Flowers dark reddish.

YUNNAN: eastern flank of the Tali Range, *Forrest* 4501 (ANSP, NTU, UCLA).

A species related to *P. yunnanensis* but readily distinguished by its more hairy habit, larger leaves and larger corolla with relatively longer tube, shorter beak, and glabrous lower lip. Only the anterior staminal filaments are sparsely hairy, the posterior ones being glabrous. In *P. yunnanensis*, all 4 filaments are hairy.

202. **Pedicularis micrantha** sp. nov. Plate 9, fig. 164.

Planta perennis, circiter 2 dm. alta, inflorescentiis exceptis glabra; radicibus pluribus, filiformibus, paulo crassis; caulibus singulis simplicibus erectis rigidis, pauce foliatis; foliis radicalibus multis longe petiolatis, ad 15 cm. longis, petiolis gracilibus ad 7 cm. longis, glabris, laminis membranaceis utrinque glabris oblongo-ovatis, acutis, 6-7.5 cm. longis, 2-2.7 cm. latis, pinnatifidis, segmentis utrinsecus 6-8, superioribus inferioribusque valde minoribus, mediis majoribus, ovatis obtusis, basi valde dilatatis, margine crenato-pinnatifidis, denticulatis, foliis caulinis 1 vel 2, alternis, remotis, radicalibus similibus at minoribus; inflorescentiis terminalibus breviter racemosis, vix 3 cm. longis, tomentosis, multifloribus, superne compactis, inferne laxis; bracteis foliaceis, petiolatis, ovatis pinnatifidis, quam flores brevioribus; pedicellis ad 3 mm. longis, erectis, tomentosis; calyce cylindrico, circiter 7 mm. longo, parce pubescente, superne parce reticulato, antice leviter fisso, 5-dentato, dentibus inaequalibus, dente posteriore minore deltoideo acuto, caeteris late ovatis, basi leviter constrictis, superne plus minusve 3-dentatis, dentibus posterioribus plerumque minoribus; corollā roseā, vix 1.2 cm. longā: tubo recto, calycem leviter superante, superne ampliato; galeā falcatā, in rostrum longum productā; rostro gracili filiformi ad 5 mm. longo horizontali, leviter curvato; labio inferiore superius subaequante, margine ciliato, 3-lobato, lobis rotundatis subaequalibus, lobo medio subporrecto; staminibus ad medium tubi insertis, filamentis anterioribus ad apicem villosis; stylo exserto; capsulis ignotis.

Type, margins of thickets, at an altitude of 3100 meters, Tsuhwang, Salween-Kiukiang divide, Yunnan Province, collected in flower, Sept. 17, 1938, by T. T. Yü, No. 20344; holotype in the herbarium of the Arnold Arboretum. Flowers pink. Only collection seen.

The kinship of this species appears to be with the Paucifoliatae, but it may belong elsewhere. It is especially characterized by the large, membranaceous, mostly basal leaves which are pinnatifid, and by the small flowers, the calyx of which has a slightly cleft tube and short teeth while the corolla has a short tube and a distinct slender beak.

203. **Pedicularis yunnanesis** Franchet Plate 9, fig. 165.

Pedicularis yunnanensis Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 572, fig. 70, 1888; in Mél. Biol., 12: 851, fig. 70, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 220, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 86, 1911; 7: 242, 1912; Limpricht, in Repert. Sp. Nov., 20: 236, 1924. The type was from: "Yunnan, monte Tsang-chan supra Tali, 4000 m.s.m. (Delavay! in herb. Paris)." Several sheets of this type collection are in the Bonati Herbarium, and one duplicate is in the United States National Herbarium. All of them bear the number *Delavay* 1100.

Alpine meadows at altitudes of 3050 to 4000 meters in northwestern Yunnan. Flowers magenta-rose. Flowering from June to September.

YUNNAN: Tsang-shan above Tali, *Delavay* 1100 (ANSP, NTU, UCLA, USNH), s.n. (NYBG, UCLA); eastern flank of the Tali Range, *Forrest* 4499 (ANSP, UCLA), 11563 (ANSP, UC); Moku-ji Pass, *Farrer* 1784 (RBGE).

This species has a single stem with a cluster of fibrous roots frequently greatly enlarged in the middle. It has a few long-petiolate radical leaves together with some membranaceous lanceolate scales transformed from petioles. The calyx is slightly cleft anteriorly. Although Maximowicz described the longer filaments as hairy he depicted both pairs as hairy, which is the case as observed on the many type specimens available.

204. **Pedicularis aphyllocaulis** Handel-Mazzetti Plate 9, fig. 166.

Pedicularis aphyllocaulis Hand.-Maz., in Anz. Akad. Wiss. Wien Math.-Nat. Kl., 62: 239, 1925; Symb. Sin., 7: 858, pl. 15, fig. 6, 1936; Limpricht, in Repert. Sp. Nov., 23: 336, 1927. Originally Handel-Mazzetti cited two collections of his own for this species: "Prov. Yunnan bor.-occ.: in cespite alpino jugorum Nisselaka inter fluvios Mekong et Salwin legi 18. VI. 1916 (Nr. 8959) et Tschiangschel inter hunc et Irrawadi legi 4. VII. 1916 (Nr. 9265), 27° 52′-28°, s[olo] micoschistaceo, 3950–4200 *m*." In a later redescription of the species (l.c., 1936) he indicated that his 9265 was the type, and cited in addition *Forrest* 18718, 19304. The type, as well as the other collections cited by the author, has not been seen.

Alpine meadows at altitudes of 3600 to 4200 meters in northwestern Yunnan. Flowers purplish red. Flowering from June to August.

YUNNAN: Atungtze, *Ward* 566 (RBGE); Tali, *C. W. Wang* 63185 (AA); Mekong-Salween divide, Sila, *Yü* 22235 (AA), 22347 (AA).

A species very close to *P. yunnanensis* but differing in the narrower and longer leaves. Handel-Mazzetti originally contrasted this with *P. yunnanensis* as having 4 instead of 2 hairy filaments. However, the latter also has all its filaments hairy. The chief difference betwen the two species is in the leaf shape and size. With more ample material it may prove desirable to treat *P. aphyllocaulis* as a variety of *P. yunnanensis*.

205. **Pedicularis forrestiana** Bonati Plate 9, fig. 167.

Pedicularis forrestiana Bonati, in Notes Bot. Gard. Edinb., 5: 86, pl. 73, 1911; 7: 155, 1912; 15: 159, 1926; Limpricht, in Repert. Sp. Nov., 20: 236, 1924; 23: 336, 1927. The type was from northwestern Yunnan: "'Dry open situations on limestone drift at base of cliffs on the eastern flank of the Lichiang Range, Lat. 27° 25′ N. Alt. 11-12,000 ft.' G. Forrest. No. 2703." An isotype from the Bonati Herbarium, divides between the Academy of Natural Sciences of Philadelphia and the University of California at Los Angeles.

Alpine meadows or open situations at altitudes of 3350 to 4000 meters in northwestern Yunnan. Flowers bright rose-red. Flowering in July and August.

YUNNAN: no data, *Forrest* s.n. (ANSP, UCLA); eastern flank of the Likiang Range, *Forrest* 2703 (ANSP, UCLA), *Rock* 4745 (USNH), 4864 (ANSP, UC, USNH); northwest of the Yangtze bend, *Forrest* 10360 (ANSP, GH, UC); Chungtien Plateau, *Forrest* 10597 (UCLA); Kari Pass, Mekong-Yangtze divide, *Forrest* 13130 (ANSP); Likiang, *Schneider* 2004 (GH); Kin-tzu Shan or Dsho-yu nvlu, district of Labako, west of Shi-Ku, *Rock* 25137 (NYBG, UC, UP).

A species related to *P. tsangchanensis* but differing in general habit. It is much less hairy and has shallowly pinnatifid leaves and a more rigid stem. In the floral structures it also differs in the slightly shorter corolla with ciliate-margined lower lip, shorter and flabellate calyx-teeth and 4 hairy staminal filaments.

Series 56. Macrorhynchae ser. nov.

Medium-sized plants; root much thickened; stems single or several, puberulous, simple, few-leaved or leafless; leaves mostly radical, long-petiolate, oblong-lanceolate, pinnatisect, the segments oblong to oblong-ovate, pinnatifid, the apex acute, the base broad and adnate; inflorescences terminal, long; flowers very short-pedicellate; lower bracts foliaceous, pinnatifid; upper bracts 3-lobed and serrate; calyx cylindric, hairy externally, scarcely reticulate, cleft ½ anteriorly, 5-dentate, the mid-posterior smaller, subentire or serrate, the others ovate, serrate; corolla purplish red, the tube cylindric, longer than the calyx, erect proximally, bending at the very distal part; galea erect, the beak long, slender, often sigmoid; lower lip very small, shorter than the galea, 3-lobed, the lobes rounded, the margins glabrous, the middle lobe prominently distad; stamens inserted at the upper part of the tube, the filaments all hairy; stigmas exserted.

One species in northwestern Yunnan (Map 31).

The relationship of this series is probably with the Filiculae, the Rhinanthoides, and the Kialenses, the latter two having similar types of calyces. But in the corolla-tube which bends at the top, and in the very small lower lip, this series is quite different from them. It is also somewhat related to the Megalanthae, a series of the western to eastern Himalayas. In leaf-characters it is particularly like *P. filicula.*

206. Pedicularis macrorhyncha sp. nov. Plate 10, fig. 168.

Planta perennis, circiter 2.5 dm. alta; radice verticali valde crassā; caulibus singulis vel multis, crassis, puberulis, simplicibus, efoliatis vel paucifoliatis; foliis radicalibus multis longe petiolatis: petiolis 2-5 cm. longis, gracilibus, puberulis, laminis oblongo-lanceolatis, ad 10 cm. longis et 2.5 cm. latis, pinnatisectis; utrinque puberulis, infra ad costam plerumque villosis, segmentis utrinsecus 15-20, remotis vel approximatis, oblongis vel oblongo-ovatis, pinnatifidis, apice acutis, basi late adnatis; foliis caulinis alternis, paucis vel nullis, radicalibus parvioribus; inflorescentiis terminalibus prominentibus, 8-12.5 cm. longis, floribus sparsis, pedicellis 2-3 mm.

longis; bracteis inferioribus foliaceis, ad 1.2 cm. longis, oblongis, pinnatifidis, subsessilibus; bracteis superioribus 3-lobatis, serratis, basi latis; calyce cylindrico, 1-1.2 cm. longo, externe pubescente, membranaceo, vix reticulato, antice ad ¼ fisso, 5-dentato, dentibus subaequalibus vel inaequalibus, dente posteriore parvo, subintegro vel serrato, caeteris ovatis, serratis; corollā purpureo-rubrā, 3.2 cm. longā: tubo cylindrico, erecto, ad 1.8 cm. longo, superne curvato, vix dilatato; galeā 7-9 mm. longā, rectā, apice in rostrum longum productā; rostro 1.5 cm. longo, gracili, sublevato, incurvato vel sigmoideo; labio inferiore minore, 5-6 mm. longo, 3-lobato, lobis rotundatis, subaequalibus, margine glabris, lobo medio prominente, porrecto; staminibus ad tubi ⅔ longitudinem insertis, filamentis villosis; stylo exserto; capsulis ignotis.

Type, on open hillside, Chungtien Plateau, northwestern Yunnan, collected in flower, July 9, 1939, by K. M. Feng, No. 1595; holotype in the herbarium of the Arnold Arboretum.

Alpine meadows at an altitude of about 3660 meters in northwestern Yunnan. Flowers purplish red. Flowering from May to August.

YUNNAN: Lao-chun Shan, southwest of Shi-ku and the Yangtze, *Rock* 25092 (CM, MBG, NYBG, UC, UP, USNH); Chungtien Plateau, *Feng* 1595 (AA); northeast of Likiang, Tzai-koo Snow Mountain, *Ching* 21278 (AA); no precise localities, *Yü* 11802 (AA), *Forrest* 28804 (ANSP).

A very distinct species strongly characterized by the long, prominent, often sigmoid beak and the small short lower lip. The corolla is characteristically bent at the very distal part of the tube. The calyx resembles those of *P. rhinanthoides* and *P. kialensis*, but the other characters are very different.

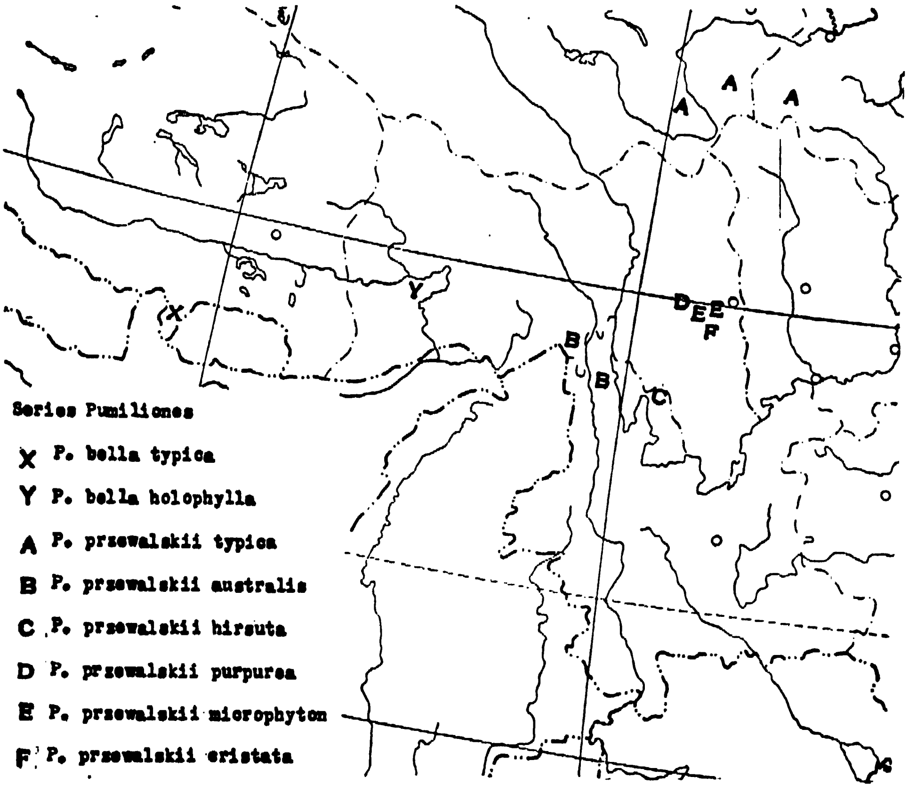
Series 57. Pumiliones

Pumiliones Prain, in Ann. Bot. Gard. Calcutta, 3: 69, 1890.

Very low plants, acaulescent or nearly so, caespitose, villose; leaves mostly basal, long-petiolate, sometimes the petioles forming narrowly oblong and obtuse bracts, the blades ovate, shallowly crenate to rarely entire; flowers mostly basal, pedicellate; calyx cylindric-campanulate, villose, not reticulate, cleft anteriorly, 5-dentate, the teeth equal to subequal, the posterior sometimes smaller, the others ovate and serrate; corolla purple to red or white with purple galea, the tube cylindric, erect, 3-4 times as long as the calyx, pubescent externally; galea falcate, cristate in front or not, projected into a straight or sigmoid, more or less filiform beak, the apex entire or bifid; lower lip usually glabrous on the margins, rarely ciliate, 3-lobed, the lobes equal or the middle lobe smaller; stamens inserted near the throat of the tube; filaments all hairy; capsule elongate, acute, scarcely compressed.

Two species along the Himalayas to northwestern Yunnan, northward to Sikang, Shinghai and Kansu (May 32).

The relationship of the series is probably with the Robustae of the eastern Himalayas and with the Macranthae. This series is characterized by extremely low habit, crenate leaves and long-tubular corollas.



Map 32.—Distribution of the series Pumiliones.

Key to the Species

A. Corolla purple, the beak sigmoid, entire, the middle lobe of the lower lip ovate, narrower, much smaller than the lateral lobes. .... 207. *P. bella*

AA. Corolla white, purple or red, the beak straight, bifid, the middle lobe of the lower lip rounded to emarginate, broad, as large as the lateral lobes. 208. *P. przewalskii*

207. Pedicularis bella J. D. Hooker

This species of the eastern Himalayas has not been reported in the east in Sikang or Yunnan. Marquand & Shaw however have described a variety together with a form from Sikang.

Key to the Varieties

A. Leaves crenate. .... 207a. *P. b. typica*

AA. Leaves entire. .... 207b. *P. b. holophylla*

207a. Pedicularis bella typica

Pedicularis bella Hook. f., Fl. Brit. Ind., **4**: 313, 1884; Maxim., in Bull. Acad. St. Pétersb., **32**: 528, fig. 3, 1888; in Mél. Biol., **12**: 787, fig. 3, 1888; Limpricht, in

Repert. Sp. Nov., 20: 254, 1920. Hooker's type was collected by himself from Sikkim: "Sikkim Himalaya, Kongra Lama, alt. 16,000 ft., *J. D. H*[*ooker*]."

At an altitude of about 4880 meters in the eastern Himalayas from Sikkim, Chumbi, to western Tibet (ex Maximowicz). Flowers dark purple. Flowering in June and July.

TIBET: Chumbi Valley, Temu La, *R. Lepcha* 378 (ANSP).

207b. **Pedicularis bella holophylla** Marquand & Shaw

Pedicularis bella Hook. f. var. *holophylla* Marquand & Shaw ex Marquand, in Journ. Linn. Soc. Bot., 48: 211, 1929. The type, "S.E. Tibet: Flowers deep crimson. On open grass slopes in the upper *Rhododendron* forest. Tang La, 3600-3900 m., July 17, 1924, *F. Kingdon Ward* 5942," has not been seen.

In Sikang. Flowers deep crimson. Flowering in July. Known from the original collection only. No specimen seen.

The exact nature of the variety is not fully known. Marquand and Shaw simply described the variety as differing from the typical form of the species in the leaves being entire. Strictly entire-leaved species of the genus *Pedicularis* have not been so far discovered. The nearest to this condition is found in *P. integerrima* which is similarly a low plant with long-tubular, purplish to reddish corolla bearing a sigmoid beak. *P. integerrima* appears at a glance quite like *P. bella*. It is doubtful whether Marquand & Shaw's variety is really referable to the latter species. A paler form was also described by them.

207b-1. **Pedicularis bella holophylla** f. **rosea** Marquand & Shaw

Pedicularis bella Hook. f. var. *holophylla* Marquand & Shaw f. *rosea* Marquand & Shaw ex Marquand, in Journ. Linn. Soc. Bot., 48: 211, 1929. The type, "S.E. Tibet: Flowers pink. In alpine pastures on Nam La, 4200 m., July 23, 1924, *F. Kingdon Ward* 5975," has not been seen. Known from the original collection only. No specimen seen.

208. **Pedicularis przewalskii** Maximowicz

This species, here understood to include *P. microphyton* and *P. coppeyi*, shows several geographically distinct varieties. Each of these has certain distinct characteristics but these overlap and intergrade. *P. coppeyi* was first described by Bonati as a variety of *P. microphyton*. In raising the latter to specific rank Bonati mentioned (Bull. Soc. Bot. France, 57: Sess. Extraord.: lviii, 1910) that *P. microphyton* is scarcely different from *P. przewalskii* and the two were considered by some to be conspecific. Nevertheless he concluded that the two were distinct and at the same time inaugurated *P. coppeyi*. With the larger series of specimens from various localities now available I think that only one species, although with several varieties, is to be recognized.

The typical form of the species occurs in southern Kansu and northern Chinghai. With the same type of leaf-serration and pubescence are two varieties in northwestern Yunnan and adjacent Sikang, *australis* and *hirsuta*.

In between geographically are var. *purpurea* (*P. coppeyi* Bonati), var. *microphyton*, and var. *cristata*. Prain (in Journ. As. Soc. Beng., 58 (2): 270, 1889; in Ann. Bot. Gard. Calcutta, 3: 120, 1890), also recorded *P. przewalskii* from Phari, in the eastern Himalayas. It may be that this is the same as var. *australis* or that another unnamed variety is represented.

Key to the Varieties

A. Corolla purple to red throughout, the beak often darkest; margins of the lower lip glabrous or ciliate; calyx-teeth 2-3 or 5.

  B. Margins of the lower lip glabrous; calyx-teeth 5.

    C. Leaf-blades sparsely hairy above especially distally, the margins not ciliate; corolla rose to deep red. .... 208a. *P. p. typica*

    CC. Leaf-blades more or less densely hairy throughout, the margins ciliate; corolla purple to purplish red.

      D. Leaf-blades smaller, scarcely to 1.5 cm. long and 5 mm. wide; corolla purplish red throughout. .... 208b. *P. p. australis*

      DD. Leaf-blades slightly larger, to 2.2 cm. long and 8 mm. wide; corolla purple, the beak excepted, becoming pale when dry. 208c. *P. p. hirsuta*

  BB. Margins of the lower lip ciliate; calyx-teeth 2-3. ...... 208d. *P. p. purpurea*

AA. Corolla white to cream-colored, the beak purple; margins of the lower lip glabrous; calyx-teeth 5.

  B. Leaf-blades densely pubescent, the hairs glandular, the blades ovate to ovate-oblong, broad, 6-7 mm. wide, shallowly crenate to about ⅓ the length from the margin to the midrib; galea not crested. ...... 208e. *P. p. microphyton*

  BB. Leaf-blades sparsely pubescent to glabrate above, the hairs not glandular, the blades oblong to linear-oblong, 5-6 mm. wide, deeply crenate to about half way from the margins to the midrib; galea usually crested. 208f. *P. p. cristata*

208a. Pedicularis przewalskii typica Plate 10, fig. 169.

Pedicularis przewalskii Maxim., in Bull. Acad. St. Pétersb., 24: 55, 1878; 32: 528, fig. 2, 1888; in Mél. Biol., 10: 84, 1878; 12: 787, fig. 2, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 214, 1890; Limpricht, in Repert. Sp. Nov., 20: 254, 1924, p.p.; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 34, 1933. The types were from Kansu: "Prov. Kansu, pratis alpinis regionis altissimae frequens (Przewalski)." A specimen gathered subsequent to the type, *Przewalski* s.n., from the Tangut region, Kansu Province, collected in 1880, from the Bonati Herbarium, passes to the Academy of Natural Sciences of Philadelphia. Another specimen from Chinghai Province, labelled: "*Pedicularis przewalskii* Maxim. Tibet borealis. Ad. fluvium Diao-tschu, 29, VI.-11, VII. 1887. Leg. N. M. Przewalski. Determ. Maximowicz," in Maximowicz's own handwriting, also in the Bonati Herbarium, will pass to the University of California at Los Angeles. This was cited by Maximowicz in 1888, when the illustration was made.

Alpine moist meadows at an altitude of about 4000 meters in southern Kansu and northeastern Chinghai. Flowers rose to deep red. Flowering in June and July.

KANSU: Tangut region, *Przewalski* s.n. (ANSP); Da-Tung, *Farrer* 713 (RBGE).

CHINGHAI: Diao-tschu, *Przewalski* s.n. (UCLA); Amnyi Machen range (west of Yellow River), Mt. Druggu, *Rock* 14438 (ANSP, GH).

The typical form of the species as here defined is limited in its distribution to southern Kansu and northeastern Chinghai, occupying the northern-most range of the species. The leaves are crenate to about midway from the margins to the midrib, hairy above but very sparsely so to almost glabrous distally. The corolla has the deepest red color among all the varieties of the species.

208b. **Pedicularis przewalskii australis** var. nov.

A typo speciei differt foliis ad 1.5 cm. longis, 5 mm. latis, utrinque dense hirsutis, margine ciliatis; corollā purpureo-rubrā.

Type, in alpine meadows at an altitude of about 4400 meters, Pei-ma Shan, Mekong-Yangtze divide, southeast of Atuntze, Yunnan Province, collected in flower May 1932, by J. F. Rock, No. 22840; holotype in the United States National Herbarium; isotypes in the herbaria of the Chicago Natural History Museum, the Missouri Botanical Garden, the New York Botanical Garden, the University of California, and the University of Pennsylvania.

Alpine meadows at altitudes of 4300 to 4400 meters in northwestern Yunnan and adjacent southern Sikang. Flowers purplish red. Flowering from May to June.

SIKANG: Ka-gur-pu, Mekong-Salween divide, *Forrest* s.n. (ANSP).

YUNNAN: Pei-ma-Shan, Mekong-Yangtze divide, southeast of Atuntze, *Rock* 22840 (CM, MBG, NYBG, UC, UP, USNH); no precise locality, *Yü* 9160 (AA).

Among the different varieties this one, in spite of its remote geographical range, is closest to the typical form of the species. It has, however, smaller leaves which are more densely hairy and ciliate on the margins. The color of the flower is also more purplish.

208c. **Pedicularis przewalskii hirsuta** var. nov.

A typo speciei differt foliis ad 2.2 cm. longis, 8 mm. latis, utrinque dense hirsutis, margine ciliatis; corollā purpureā, in sicco rostro excepto valde pallidā.

Type, in alpine meadows at an altitude of about 4100 meters, Mt. Wuaha, Youngning territory, Yunnan Province, collected in flower, May 1932, by J. F. Rock, No. 24224; holotype in the United States National Herbarium; isotypes in the herbaria of the Chicago Natural History Museum, the Missouri Botanical Garden, the New York Botanical Garden, the University of California, and the University of Pennsylvania. Flowers purple. Only collection seen.

This variety resembles var. *australis* in the densely hairy leaves which are ciliate on the margins. The leaves are slightly larger and are like the *typica* and *australis*, crenate to about midway from the margins to the midrib. The corolla, as indicated on the field notes, is purple. In the dried specimens the corolla is pale and yellowish except the beak which is rather dark. It resembles closely the dried condition of var. *microphyton* which has whitish corolla with purplish beak. Apparently the color of the corolla of var. *hirsuta* is intermediate between the whitish and purplish one of var. *microphyton* and the purple-reddish one of var. *australis*.

208d. **Pedicularis przewalskii purpurea** (Bonati) comb. nov.

Pedicularis microphyton Bur. & Franch. var. *purpurea* Bonati, in Bull. Soc. Bot. France, 55: 244, 1908. The types were from Sikang: "Yargong (Soulié) n^{os} 5289 et 3753 (1904)." These have not been seen.

Pedicularis coppeyi Bonati, in Bull. Soc. Bot. France, 57: Sess. Extraord.: lviii, 1910; Limpricht, in Repert. Sp. Nov., 20: 255, 1925. Based on the above.

Sikang. Flowers purple. No specimen seen.

According to Bonati this variety has 2-3-dentate calyx and purple corolla with the lower lip ciliate on the margins. Handel-Mazzetti (Symb. Sin., 7: 865, 1936) mentioned that in *P. microphyton* the calyx varies in some flowers in having 2-3 teeth instead of 5. The number of teeth on the calyx apparently varies in *P. przewalskii* and is not constant enough for specific recognition.

208e. **Pedicularis przewalskii microphyton** (Bureau & Franchet) comb. nov.

Pedicularis microphyton Bur. & Franch., in Morot, Journ. de Bot., 5: 107, 1891; Bonati, in Bull. Soc. Bot. France, 54: 184, 1907; Limpricht, in Repert. Sp. Nov. Beih., 12: 484, 1922; in Repert. Sp. Nov., 20: 255, 1924; Hand.-Maz., Symb. Sin., 7: 865, 1936. The type was from Sikang: "Se-tchuen, entre Batang et Litang, sur les gazons secs et sur les coteaux avant Ta-tsien-lou [pendant la voyage de M. Bonvalet et du Prince Henri d'Orléans en 1890]." It has not been seen.

Alpine meadows at altitudes of 4600 to 4830 meters in Sikang. Flowers white to cream-colored, the beak purple. Flowering from June to August.

SIKANG: Vallie de Doy, *Soulié* 2837 (NYBG); Litang River divide, *Ward* 4226 (RBGE); Djesi-La and Djesi-Longba, south of Tatsienlu, *Rock* 17709 (ANSP, USNH); no precise localities, *Forrest* 28676 (ANSP), 30063 (ANSP).

This variety has the broadest and most shallowly crenate leaves. In all other varieties the leaves cut to about one-half the length from the margins to the midrib. In var. *microphyton* the leaves cut to only about one-third the length. They are also rather densely pubescent. The hairs on the leaves are glandular at their tips. In other varieties the hairs, which are also uniseriately multicellular, are pointed at their tips.

208f. **Pedicularis przewalskii cristata** var. nov.

A typo speciei differt corollā pallidā, rostro purpureo; galeā fronte plerumque triangulari-cristatā.

Type, in alpine meadows at an altitude of 4800 meters in Mount Konka, Risonquemba, Konkaling, Sikang Province, collected in flower, June 1928, by J. F. Rock, No. 16373; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotype in the United States National Herbarium.

Alpine meadows at altitudes of 4700 to 4830 meters on Mount Konka, Sikang Province. Flowers white with purple beak. Flowering from June to August.

SIKANG: Mount Konka, Risonquemba, Konkaling, *Rock* 16306 (ANSP, USNH), 16373 (ANSP, USNH), 16841 (ANSP, USNH).

In the corolla color this variety resembles var. *microphyton*. It differs from the latter in the galea being often triangularly cristate in front and in the narrower, more deeply cut and more sparsely pubescent leaves, the pubescence being not glandular. In the leaf and pubescence characters it is rather close to the typical form of the species. The crest on the galea varies from distinct to entirely absent. On *Rock* 16841, one specimen bearing galea with the most distinct crest is present side by side with another where the crest is absent; otherwise the plants are exactly the same. Apparently in this species the crest character is just beginning to appear; and although distinct when present it is not constant enough for specific differentiation.

SECTION XVI. BOTRYANTHA

Medium-sized or tall plants; stems single or branching at base, sometimes branching above; leaves basal and cauline, the lower larger and longer petiolate, pinnatisect to sometimes deeply pinnatifid, the segments pinnatifid to serrate, sometimes pinnatisect; inflorescences in short racemes or spikes, usually few-flowered; calyx campanulate, cleft anteriorly, 2-3- or 5-dentate, the teeth entire to serrate; corolla-tube cylindric, about twice as long as the calyx; galea with a long, slender, straight or curved beak; lower lip 3-lobed, the middle lobe slightly smaller, not distad or very slightly so.

This section is characterized by the short few-flowered inflorescences. From section Rhizophyllum, to which it is closely related, it can also be distinguished by the more numerous cauline leaves and the deeply cleft calyx with usually fewer teeth. The range of the section extends from central Asia through the Himalayas to western and northern China.

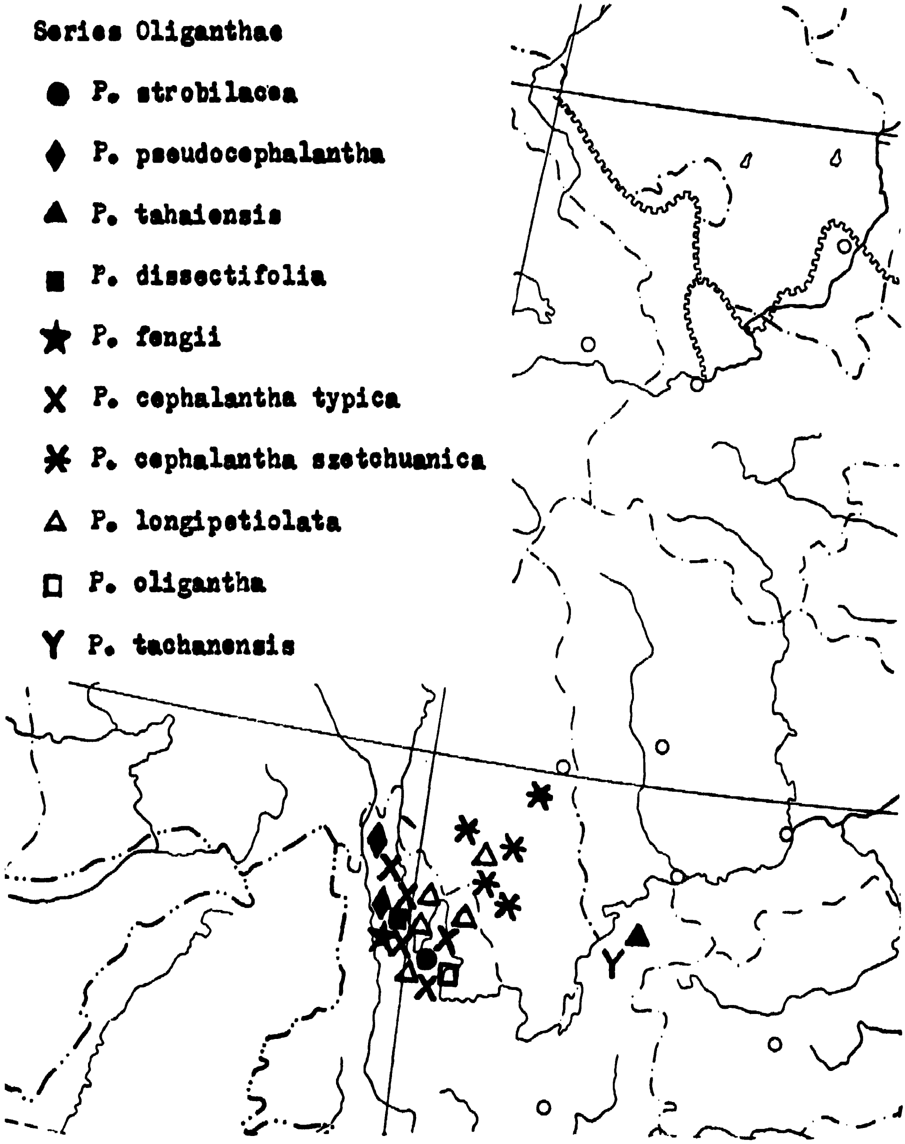
Series 58. Oliganthae

Oliganthae Prain, in Ann. Bot. Gard. Calcutta, 3: 75, 1890.

Plants medium-sized or tall; stems usually many-branched at base, sometimes also branching above; leaves basal and cauline, alternate, sometimes the lower opposite or subopposite, usually large and long-petiolate, oblong to lanceolate, pinnatisect to sometimes deeply pinnatifid, the segments oblong and serrate, sometimes pinnatisect; inflorescences in short compact racemes or spikes, few-flowered; bracts foliaceous; calyx campanulate, cleft anteriorly, 2-, 3-, or 5-dentate, the teeth entire to serrate; corolla purple, whitish or yellowish and with purplish galea, the tube longer than the calyx, cylindric, not enlarged proximally; galea sometimes with 1 tooth on one of the margins; beak long, slender, filiform; lower lip 3-lobed, the lobes ciliate or glabrous on the margins, the middle lobe smaller, not distad;

filaments inserted on the upper part of the tube, glabrous or hairy; capsule ovoid-oblong, longer than the calyx.

About 12 species in Upper Burma, northwestern Yunnan, eastern Yunnan and southern Sikang (Map 33).



Map 33.—Distribution of the series Oligantheae.

The series Oliganthae, when formed by Prain, was based on three species: *P. oligantha, P. cephalantha,* and *P. longipetiolata.* Bonati in 1921 (in Notes Bot. Gard. Edinb., 13: 119-120, 1921) prepared a key to the species, adding a number of new ones. His key, in many places as noted below, contradicts his original descriptions and is practically unworkable.

This series, as here defined, eliminates *P. margaritae* Bonati (treated as a synonym of *P. gruina* Franch. var. *cinerascens* Franch.) and admits *P. strobilacea.* The species are all characterized by a rather short and compact, few-flowered inflorescence. In this character they can be readily differentiated from those of the related series, *Oxycarpae,* which have long, lax, many-flowered racemes.

Key to the Chinese Species

A. Staminal filaments either 2 or all 4 hairy; calyx-teeth usually 5, sometimes 2 or 3, usually broad and rarely narrowed proximally.

B. Leaves deeply pinnatifid; calyx-teeth short, about as long as broad; corolla whitish or yellowish with purple galea and beak.

C. Calyx 3-dentate; galea falcate, inconspicuously cristate; beak more or less bending, pointing downward; 2 of the staminal filaments hairy. 209. *P. strobilacea*

CC. Calyx 5-dentate; galea more or less bending rectangularly, conspicuously cristate; beak horizontal, pointing outward; all 4 staminal filaments hairy. .... 210. *P. pseudo-cephalantha*

BB. Leaves pinnatisect; calyx-teeth long, about twice as long as broad; corolla purplish throughout, the galea and beak usually darkest.

C. Corolla-tube more or less hairy, the lower margin of the galea entire, the lower lip ciliate on the margins. .... 211. *P. tahaiensis*

CC. Corolla-tube glabrous externally, the lower margins of the galea often with one lanceolate reflexed tooth on one side, the lower lip glabrous on the margins.

D. Leaflets 5-7 on each side; calyx-teeth 2 or 3, the lateral ones narrowed at base.

E. Leaves basal and cauline, the basal long and slender-petiolate; leaflets bipinnatisect; stems branching at base only; beak more or less horizontal. .... 212. *P. dissectifolia*

EE. Leaves all cauline; leaflets once pinnatisect; stems branching at base and above; beak pointing obliquely downward. 213. *P. fengii*

DD. Leaflets about 10-12 on each side; calyx-teeth 5, rarely 2 or 3, scarcely narrowed at base.

E. Plant low, about 1.5-2 dm. tall; stems branching at base only; leaves mostly near base of stem, the cauline few (2-4); bracts larger, the lower to 2 cm. long; corolla about 18-23 mm. long; calyx-teeth 2, 3 or 5, entire to dentate. 214. *P. cephalantha*

EE. Plant larger, about 3-5 dm. tall; stems branching both at base and above; leaves basal and cauline, the cauline many; bracts smaller, the lower to 1.5 cm. long; corolla about 23-30 mm. long; calyx-teeth 5, incised and dentate. 215. P. *longepetiolata*

AA. Staminal filaments all glabrous; calyx-teeth 2, flabellate distally, narrowed at base, sometimes with an additional posterior small and entire tooth.

B. Corolla yellow; galea not cristate. .... 216. *P. oligantha*
BB. Corolla rose; galea prominently cristate. .... 217. *P. tachanensis*

209. Pedicularis strobilacea Franchet Plate 10, fig. 170.

Pedicularis strobilacea Franch. ex Hemsl., in Journ. Linn. Soc. Bot., 26: 216, 1890; Limpricht, in Repert. Sp. Nov., 20: 249, 1924. The type was from northwestern Yunnan: " Yunnan, in meadows, Mount Yentzehay, at 3500 meters (Delavay, 3402, ex Franchet)." Isotypes are in the Bonati Herbarium, the Academy of Natural Sciences of Philadelphia, University of California at Los Angeles, and at the New York Botanical Garden.

Alpine meadows at an altitude of about 3500 meters in northwestern Yunnan. Flowers whitish with purple galea. Flowering in July and August.

YUNNAN: Yentzehay, *Delavay* 3402 (ANSP, NTU, NYBG, UCLA); Lao long tang, Yentzehay, *Delavay* s.n. (ANSP).

This species has stems usually branched near the base and profoundly pinnatifid leaves which are alternate but with some of the lower ones opposite or subopposite. The flowers are in short compact racemes with sessile and dilated bracts. The corolla is characteristically whitish with purplish galea and beak.

The inclusion of this short-tubular species in the series Longiflorae, first by Prain (in Ann. Bot. Gard. Calcutta, 3: 67, 1890) and later followed by Bonati (in Notes Bot. Gard. Edinb., 13: 108, 1921) and Limpricht (l.c.), is surely very inappropriate. Prain apparently did not have access to any specimen of Franchet's species but he stated (op. cit., 58) that *P. strobilacea* is " apparently a Siphonantha and probably a Longiflora." That the assignment is not correct was evidently noted by Bonati who queerly retained the species in the series Longiflorae while describing a variety, var. *riparia*, which he placed in the series Oliganthae. It is not possible to explain how a species could be placed in one series while a variety of the same species could be put into another; and according to Prain's system the series Oliganthae is in the Division Aduncae while the Longiflorae is in the Division Longirostres! The proper position of *P. strobilacea* is undoubtedly in the series Oliganthae.

210. Pedicularis pseudocephalantha Bonati Plate 10, fig. 171.

Pedicularis pseudocephalantha Bonati, in Bull. Soc. Bot. Genève II, 5: 314, fig. 13, 1, 1913; Limpricht, in Repert. Sp. Nov., 20: 245, 1924. The type, " Tsékou, Thibet oriental (Monbeig)," has not been seen. The type locality is in northwestern Yunnan, close to the Sikang border.

Pedicularis strobilacea Franch. var. *riparia* Bonati, in Notes Bot. Gard. Edinb., 13: 117, 1921; 17: 63, 80, 1929; Limpricht, in Repert. Sp. Nov., 20: 249, 1924. Bonati originally cited three collections: " ' N.W. Yunnan. By streams in forest. Alt. 10-11,000 ft. July 1913.' F. Kingdon Ward. No. 683. ' Mekong-Salween divide, Yunnan, in alpine meadows. Lat. 28° 12′ N. Alt. 13,000 ft. Plant of 9-12 ins. Flowers white or pale rose, beak deep crimson. July 1917.' G. Forrest. Nos. 14,367, 14,581." Duplicates of the two Forrest numbers are in the Bonati Herbarium. Bonati described the staminal filaments as villose, but he mentioned in his notes " In var. *riparia* two staminal filaments are densely hairy, the two others less so, but they are not glabrous." This is the actual case as observed in the available specimens. In this character as well as in the calyx-structure this variety agrees so closely with *P. pseudocephalantha* as to show that the same species is represented. In the original description Bonati described the corolla-tube as equaling the calyx in length, but in the specimens the tube is about twice as long as the calyx.

Alpine meadows at altitudes of about 2700 to 4000 meters in northwestern Yunnan. Flowers cream-white with deep rose beak. Flowering in July and August.

YUNNAN: Mekong-Salween divide, *Forrest* 14367 (ANSP, NTU, UCLA), 14581 (ANSP, UCLA); Bei-ma-shan, *Forrest* 19615 (ANSP, UCLA); Atuntze, *C. W. Wang* 69899 (AA), 68785 (AA); Wei-si District, Yeh-chih, *C. W. Wang* 68371 (AA); Sewalongba, Mekong-Salween divide, *Yü* 22463 (AA); no precise locality, *Yü* 9776 (AA), 9616 (AA).

This species is most closely related to *P. strobilacea*. In general appearance it resembles the latter especially in the branching of the stems, in the leaves, and in the flower color. It differs, however, in the calyx being 5- instead of 3-dentate, in the galea bending rectangularly and being more abruptly contracted into the beak which is straight or slightly arched distally, and in four instead of two filaments being glabrous. In *P. strobilacea* the galea is falcate with less prominent crest and with a more incurved beak. A comparison of the figures showing their flowers will readily reveal the differences in the galea and the beak.

211. **Pedicularis tahaiensis** Bonati Plate 10, fig. 172.

Pedicularis tahaiensis Bonati, in Notes Bot. Gard. Edinb., 13: 114, 1921; Limpricht, in Repert. Sp. Nov., 20: 245. 1924. The type was from " Eastern Yunnan:—'Pedicularis annuel; fl. roses. Pâturages, plateau de Tai-hai. Alt. 3200 m. Juillet 1913.' E. E. Maire. No. 678." An isotype is in the Bonati Herbarium.

Alpine meadows at an altitude of about 3200 meters in northeastern Yunnan. Flowers rose. Flowering in July and August.

YUNNAN: Ta-hai, *Maire* 678 (ANSP); no precise locality, *Maire* s.n. (ANSP, UCLA), 6787 (UCLA).

This species is characterized by 2-dentate calyx, more or less hairy corolla-tube, strongly cristate galea and profoundly bifid beak.

212. **Pedicularis dissectifolia** sp. nov. Plate 10, fig. 173.

Perennis, circiter 2 dm. alta; rhizomata verticale elongata, radicalibus filiformibus, multis; caulibus singulis vel pluribus, erectis, glabratis, simplicibus; foliis radicalibus caulinisque, radicalibus pluribus longe petiolatis, petiolis gracilibus, ad 9 cm. longis, laminis oblongo-ovatis, 3-3.5 cm. longis, 1.5-1.8 cm. latis, utrinque glabris, bipinnatisectis, segmentis utrinsecus 5 vel 6, ovatis, pinnatisectis vel ad apicem pinnatifidis, lobulis ovatis, inciso-dentatis, foliis caulinis 2 vel 3 alternis, quam radicalia minoribus et breviter petiolatis, petiolis 1-2.5 cm. longis, laminis ad 2.5 cm. longis et 1.5 cm. latis; inflorescentiis terminalibus, brevibus, plus minusve compactis, paucifloris; pedicellis vix 1 mm. longis vel nullis; bracteis foliaceis, ad 1.2 cm. longis, basi breviter petiolatis, laminis pinnatisectis; calyce ovoideo, 5 mm. longo, membranaceo, sparse villoso, antice ad medium fisso, 2- vel 3-dentato, nervis

circiter 5, haud reticulatis, dente posteriore acuto, minore vel nullo, dentibus lateralibus basi constrictis, superne dilatatis, ovatis, 2-3-dentatis; corollā purpureā (?), circiter 1.7 cm. longā: tubo calycem duplo superante, cylindrico, externe glabro, superne vix dilatato; galeā falciformi, in parte basali brevi, in partis horizontalis margine uno cum dente distinctissimo inflexo fronte leviter cristatā, apice in rostrum abrupte productā; rostro filiformi, gracili, horizontale, recto vel paulo curvato, 5 mm. longo, apice leviter bifido; labio inferiore superius aequante, orbiculare, margine glabro haud profunde trilobato, lobo medio lateralibus multo minore rotundato 2 mm. longo ac lato; staminibus ad medium tubi insertis, filamentis anterioribus superne villosis, inferioribus glabris; stylo incluso; capsulis ignotis.

Type, in northwestern Yunnan, collected in 1938, by T. T. Yü, No. 6866, field data not available; holotype in the herbarium of the Arnold Arboretum. Flowers purplish (?). Only collection seen.

In the floral structure, especially the presence of a reflexed tooth on the margin of the galea, this species is undoubtedly related to *P. cephalantha* and *P. longipetiolata.* It differs from both in the calyx-teeth being only two, sometimes with a very small acute additional anterior tooth. The leaves, however, are manifestly different, the leaflets being fewer and pinnatisect to deeply pinnatifid. The basal ones have very long and slender petioles.

213. Pedicularis fengii sp. nov. Plate 10, fig. 174.

Planta elata, 2-3 dm. alta; caulibus basi rigidibus valde ramosis, erectis vel arcuato-adscendentibus, glabris, superne simplicibus vel parce breviterque ramosis; foliis caulinis alternis interdum inferioribus oppositis, plus minusve longe petiolatis, petiolis ad 3.5 cm. longis, gracilibus, leviter alatis, laminis ovatis vel oblongo-ovatis, pinnatisectis, 4-5.5 cm. longis, 1.5-3.2 cm. latis, membranaceis, segmentis ovatis obtusis, distantibus, profunde pinnatifidis, lobulis oblongis dentatis acutis; inflorescentiis terminalibus in racemis brevibus compactis; bracteis foliaceis magnis, ad 2.5 cm. longis, petiolis valde alatis, margine ciliatis, pinnatisectis vel profunde pinnatifidis, glabris; pedicellis ad 5 mm. longis; calycibus ovoideis, membranaceis, glabris, circiter 6 mm. longis, circiter 3-nervis, vix reticulatis vel ad marginem reticulatis, antice ad medium fissis, 3-dentatis, dente posteriore lanceolato acuto subintegro, dentibus lateralibus flabellatis, basi constrictis, superne valde inciso-lobatis, lobis dentatis; corollā roseā circiter 1.7 cm. longā: tubo erecto, calycem superante, cylindrico, superne vix dilatato; galeā falcatā, marginis inferioris uno cum dente distinctissimo inflexo fronte vix cristatā, apice in rostrum gradatim productā; rostro gracili, circiter 6 mm. longo, obliquo, subcurvato, apice haud bifido; labio inferiore superius subaequante, margine glabro, 3-lobato, lobis rotundatis, lobo medio parvo vel subporrecto; staminibus ad medium tubi insertis, filamentis longioribus ad apicem pauce villosis, antheris oblongo-ovoideis; stylis haud exsertis; capsulis oblongo-ovoideis, valde compressis, circiter 1.2 cm. longis et 6 mm. latis, acutis, calyce valde exsertis.

Type, open hillside, northern flank of the Haba Snow Range, northwestern Yunnan, collected in flower, Aug. 20, 1939, by K. M. Feng, No. 2101; holotype in the herbarium of the Arnold Arboretum.

Alpine meadows in northwestern Yunnan. Flowers rose. Flowering in August.

YUNNAN: northern flank of the Haba Snow Range, *Feng* 2101 (AA); no data, *Yü* 7613 (AA).

This species is close to *P. cephalantha* and *P. longepetiolata*, but can be distinguished by the two flabellate, deeply incised, lateral calyx-teeth with an additional posterior small oblong one, and the more strongly curved galea. In habit it also resembles *P. strobilacea*, but the latter has whitish or yellowish corollas with purplish galea instead of these being purple throughout, and it has deeply pinnatifid, instead of pinnatisect, leaves. The calyx structure is also different. That of this new species resembles *P. oligantha*, but the later, not represented by any specimen in the present study, has yellow flowers with stamens all glabrous and with an ovate tooth on each margin of the galea.

214. **Pedicularis cephalantha** Franchet

Key to the Varieties

A. Calyx-teeth 5, 2 of them pinnatilobed and the other 3 more or less entire. 214a. *P. c. typica*
AA. Calyx-teeth 2, lanceolate-acute, pinnatilobed. .... 214b. *P. c. szetchuanica*

214a. **Pedicularis cephalantha** typica Plate 10, fig. 175.

Pedicularis cephalantha Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 540, fig. 20, 1888; in Mél. Biol., 12: 805, fig. 20, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 206, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 80, 1911; 7: 141, 1912; 8: 38, 1913; 15: 162, 1926; Limpricht, in Repert. Sp. Nov., 20: 245, 1924; 23: 337, 1927; Marquand & Shaw, in Journ. Linn. Soc. Bot., 48: 211, 1929; Hand.-Maz., Symb. Sin., 7: 862, 1936. The type was from northwestern Yunnan: "prov. Yunnan, angustiis Koua-la-po inter Tali et Hokin (Delavay! in herb. Paris)." An isotype from the Bonati Herbarium, *Delavay* 98, collected July 24, 1883, passes to the University of California at Los Angeles.

Alpine meadows or in fir forests at altitudes of 4000 to 4850 meters in northwestern Yunnan. Flowers reddish purple. Flowering from June to August.

YUNNAN: no precise localities, *Forrest* 5810 (UCLA), 5925 (ANSP), *Yü* 5393 (AA), 6240 (AA), 11969 (AA), 15624 (AA); Likiang, Suee chan, *Delavay* s.n. (ANSP); Koua-la-po, en route Tali to Hokin, *Delavay* 98 (UCLA); Likiang, *Schneider* 1819 (USNH); eastern slopes of Likiang Snow Range, *Rock* 4822 (GH, USNH), 4972 (ANSP, UC, USNH); Moting shan, *Rock* 23534 (CM, MBG, NYBG, UC, UP, USNH); Mt. Satseto, eastern slopes of Likiang Snow Range, *Rock* 24842 (MBG, NYBG, UC, UP, USNH); Gussuko, slopes of Mt. Gyi-na-lo-ko, *Rock* 25000 (CM, MBG, NYBG, UC, UP, USNH); Sung-kwe pass between Likiang and Hokin, *Rock* 25196 (CM, MBG, NYBG, UC p.p.,[9] USNH); Yu-lung-shan, Likiang Snow Range, *Rock* 25356 p.p. (UC p.p., flowering specimen); Ganhaitze, southwest of the Likiang Snow Range, *Ching* 20993

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[9] See *P. elwesii* typica.

(AA); Likiang Snow Range, *Ching* 30386 (AA), 30543 (AA); Lung-pan-la, Champutung, *C. W. Wang* 71112 (AA).

This species is very closely related to *P. longepetiolata*, but their differences have not been definitely stated by Maximowicz nor later by Bonati in his key (in Notes Bot. Gard. Edinb., 13: 119-120, 1921). Maximowicz described and depicted the galea of *P. cephalantha* as crested but that of *P. longepetiolata* as not. Bonati listed both species in his key as without a crest. Actually, as observed among a large series of specimens, the galea of both species is found to be more or less slightly crested. They are also both scabrid dorsally as depicted by Maximowicz and so are not hairy in *P. cephalantha* and glabrous in *P. longepetiolata* as characterized by Bonati. As here observed the corollas of the two species are very similar in structure except that in *P. cephalantha* it is slightly smaller, about 18-23 mm. long, while in *P. longepetiolata* it is slightly larger, measuring 23-30 mm. in length. The 5 calyx-teeth of the latter are all incised and sometimes lobed, while in *P. cephalantha* 2 of them are incised while the other 3 are smaller and nearly entire. This union of the lateral teeth and their reduction in size proceed further and result in the condition found in var. *szetchuanica* where usually only two teeth are present.

The more discernible and reliable differences between the two species are in the vegetative characters. *P. cephalantha* is a smaller plant, about 1.5-2 dm. tall, with stems branching toward the base but not above. The leaves are mostly basal with a few, hardly 2-4, on the stem. The bracts are larger, the lower ones to about 2 cm. long. *P. longepetiolata* is a larger plant, up to 3-5 dm. tall, the stems being long-branched toward the base and usually short-branched above. The leaves are basal and cauline, the cauline ones being very many. The bracts are smaller, the upper ones reaching about 1.5 cm. long.

In both *P. cephalantha* and *P. longepetiolata,* Maximowicz described the presence of lanceolate inflexed teeth on the lower margins of the galea although he depicted such only in the latter species. This character, although distinct, is nevertheless not constant. The teeth may be absent, or sometimes both present and absent on the same plant; moreover, if present, they are usually found on one of the margins only. Bonati and Handel-Mazzetti had noted the same fact in *P. cephalantha* (cf. Bonati, in Notes Bot. Gard. Edinb., 13: 119, 1921).

214b. **Pedicularis cephalantha szetchuanica** Bonati

Pedicularis cephalantha Franch. var. *szetchuanica* Bonati, in Notes Bot. Gard. Edinb., 13: 118, 1921; Limpricht, in Repert. Sp. Nov., 20: 240, 1924; Hand.-Maz., Symb. Sin., 7: 862, 1936. The types, "'Szetchuan austr. inter Hunka et Waloho in pratis alt. 3000 m. Jun. 1915' Camillo Schneider; Iter chinense, 1914. . . . No. 1516. 'inter Waloho et Hunati in pratis mont. Alt. 2800 m. June 1915.' C. Schneider No. 3763," have not been seen. These localities are in the southern part of Sikang Province.

Alpine meadows at altitudes of 2800 to 4500 meters in southern Sikang. Flowers purple. Flowering in June and July.

SIKANG: Litang-Yalung divide, *Ward* 4018 (RBGE), 4370 (RBGE), 4409 (RBGE); Muli Territory, *Rock* 5551 (NYBG, USNH); Mount Konka, Risonquemba, Konkaling, *Rock* 16288 (AA); Muli Territory, between Muli Gomba and Baurong and Wa-Erh-Dje, *Rock* 16723 (ANSP, USNH); Muli Territory, mountains of Kulu, *Rock* 18062 (ANSP); Muli Territory, Mount Mitzuga, *Rock* 18243 (ANSP, USNH); Yundshi mountains, *Rock* 23598 (CM, MBG, NYBG, UC, UP, USNH); Mt. Siga, west and overlooking the Yalung River north of Karadi, *Rock* 23863b [10] (UP, USNH); Mt. Siga, *Rock* 24398 (NYBG, UC, UP, USNH); Muli Territory, Shaw-shiang-liang-tze, *Yü* 7741 (AA); Moku-ji Pass, *Farrer* 1796 (RBGE).

215. **Pedicularis longepetiolata** Franchet Plate 10, fig. 176.

Pedicularis longepetiolata Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 541, fig. 22, 1888; in Mél. Biol., 12: 806, fig. 22, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 211, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 80, 1911; 8: 38, 1913; 15: 163, 1926; Limpricht, in Repert. Sp. Nov., 20: 246, 1924. The type was from northwestern Yunnan: "China: prov. Yunnan, ad Lankong in paludibus, 2800 metr. s.m. (Delavay! in herb. Paris)." An isotype in the Bonati Herbarium, *Delavay* 720, collected on June 27, 1884, passes to the Academy of Natural Sciences of Philadelphia. The exact locality given on the field notes is "les marais de Kan hay tze sur le Hee chan men, Lan kong."

Swampy meadows at altitudes of 2900 to 3600 meters in northwestern Yunnan and southeastern Sikang. Flowers purple. Flowering from June to September.

SIKANG: northeast of Muli, *Forrest* 21379 (USNH); Muli, *Forrest* 28427 (ANSP).

YUNNAN: no precise locality, *Forrest* s.n. (ANSP, UCLA), *Forrest* 6257 (UCLA); Lankong, Hee chan men, *Delavay* 720 (ANSP); between Likiang, Youngning and Youngpei, *Rock* 5202 (USNH); eastern slopes of Likiang Snow Range, *Forrest* 3059 (ANSP, UCLA), *Rock* 5605 (USNH); eastern slopes of Likiang Snow Range, Gan Hai Tze, *Rock* 5868 (NYBG, USNH); eastern slopes of Likiang Snow Range, Chu Hyin Ko, near Nguluko, *Rock* 10624 (ANSP, GH, UC, USNH); Kanghaitze, Likiang, *Schneider* 3017 (USNH); Chungtien, *Yü* 13472 (AA); northern flank of Haba Snow Range, *Feng* 1368 (AA).

A species very similar to *P. cephalantha* in the floral structures. They may be differentiated from each other by their habitat and their calyx, as indicated in the key.

216. **Pedicularis oligantha** Franchet

Pedicularis oligantha Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 542, fig. 21, 1888; in Mél. Biol., 12: 808, fig. 21, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 213, 1890; Limpricht, in Repert. Sp. Nov., 20: 245, 1924. The type, "Yunnan, prope Lankong, sylvis prope trajectum Yen-tze-hay, 3000 m.s.m. (Delavay! in herb. Paris)," has not been seen.

In northwestern Yunnan. Flowers yellow. Known from the original collection only. No specimen seen.

It appears that this species was known only to the original authors. The corolla was described as yellow and as having a short tube about equaling the calyx in length; the calyx as 3-dentate with 2 lateral, large, flabellate and incised teeth and one small, entire posterior one; and the filaments as all glabrous.

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[10] See footnote under *P. rhinanthoides tibetica* Bonati.

217. **Pedicularis tachanensis** Bonati

Pedicularis tachanensis Bonati, in Notes Bot. Gard. Edinb., 13: 116, 1921; Limpricht, in Repert. Sp. Nov., 20: 245, 1924. The type from "East Yunnan:—'Marécages du plateau de Ta-chan. Alt. 2200 m. Pedicularis vivace; fl. roses. Août 1914.' E. E. Maire. No. 182," has not been seen.

Swampy places at an altitude of about 2200 meters in eastern Yunnan. Flowers rose. Flowering in August. Known from the original collection only. No specimen seen.

The exact relationship of this species is uncertain. Bonati described it as having all staminal filaments glabrous, the same as *P. laktangensis* Bonati, a species from Upper Burma; but in his key (in Notes Bot. Gard. Edinb., 13: 119-120, 1921) he listed these two species under the characterization " staminal filaments all hairy " together with *P. pseudocephalantha*, a species with four hairy filaments. Probably the key is erroneous and the original description should be followed.

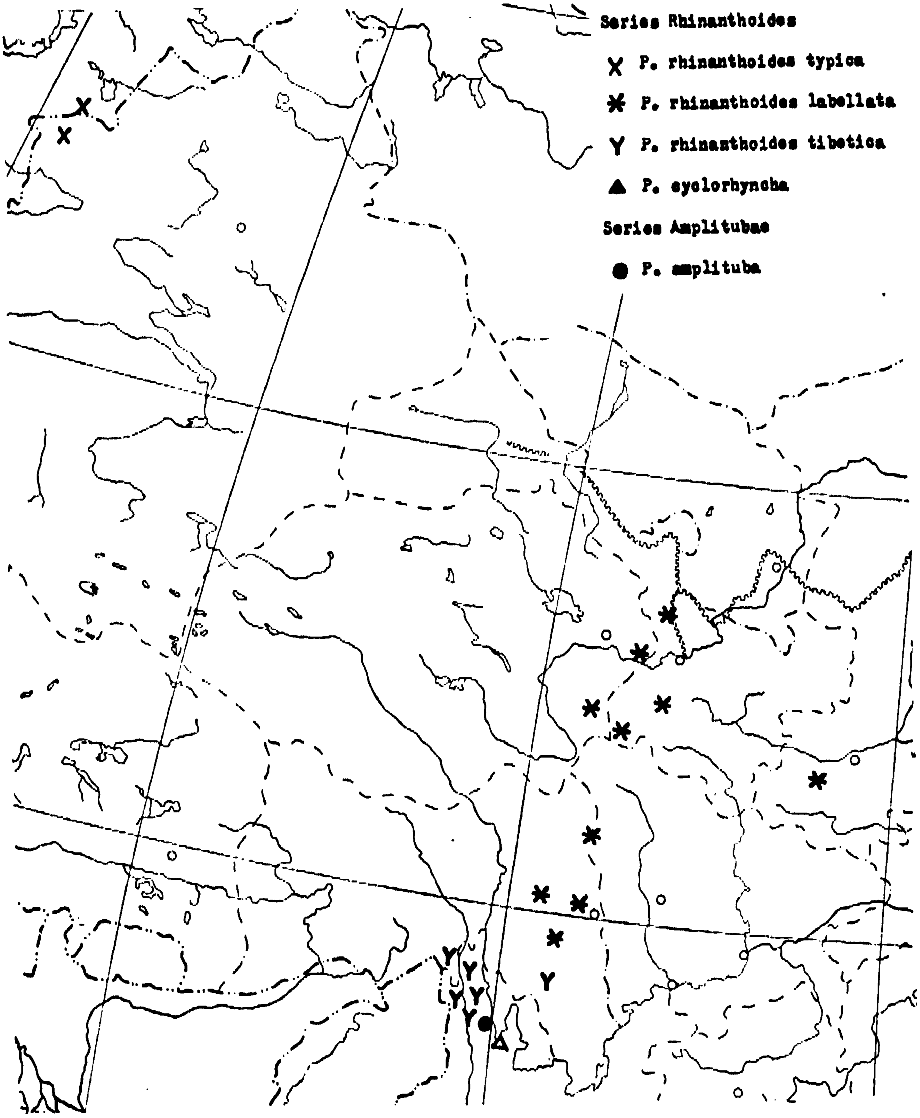
Bonati did not indicate the relationship of this species. According to his description the calyx is cleft anteriorly and with 2 flabellate teeth, the galea is prominently cristate and villose dorsally, one of the margins being provided with a refracted tooth, the lower lip is ciliate, and the staminal filaments are all glabrous. It appears to be rather close to *P. oligantha*, the latter being known also from the original collection only.

Series 59. Rhinanthoides

Rhinanthoides Prain, in Ann. Bot. Gard. Calcutta, 3: 67, 1890.

Medium-sized plants, glabrate or slightly villose; stems single or branching at base, erect or slightly spreading below; leaves radical and cauline, the cauline few, alternate, the radical very long-petiolate, the blades linear-oblong to lanceolate, pinnatisect, the segments ovate, pinnatifid to dentate; inflorescences in short terminal racemes; bracts foliaceous; flowers pedicellate; calyx ovoid, deeply or shallowly cleft anteriorly, 5-dentate, the teeth unequal, the posterior lanceolate to subulate, entire or serrate, the others ovate, serrate to sometimes lobed; corolla purple, the tube slender to about twice as long as the calyx; galea erect proximally, more or less rectangularly bent distally or curved all the way from the base, ending in a long slender curving beak; lower lip 3-lobed, the lobes rounded, subequal, the middle lobe very slightly distad, the margins glabrous or ciliate; 2 of the staminal filaments villose distally.

One species with many varieties widely distributed in the Himalayas, central Asia, to western and northern China. Another species is tentatively assigned here (Map 34).


Series Rhinanthoides
X P. rhinanthoides typica
✱ P. rhinanthoides labellata
Y P. rhinanthoides tibetica
▲ P. cyclorhyncha
Series Amplitubae
● P. amplituba

Map 34.—Distribution of the series Rhinanthoides and Amplitubae.

Key to the Species

A. Calyx deeply cleft anteriorly, 5-dentate, the posterior tooth entire, the others serrate, not lobed; galea bending at the middle, the proximal part more or less erect. .... 218. *P. rhinanthoides*

AA. Calyx shallowly cleft anteriorly, 5 dentate, the teeth all serrate, the lateral ones often 2-3-lobed; galea curving from its base, horizontal. .... 219. *P. cyclorhyncha*

218. **Pedicularis rhinanthoides** Schrenk

Currently this is interpreted as a comprehensive species occurring widely over the Himalayas to the central highland of Asia. Several varieties, more or less geographically differentiable are recognized, including *P. rhinanthoides* var. *labellata* (Jacq.) Prain, which some authors have maintained as a species. There is confusion in the identification of specimens in the herbarium. The typical form of the species occurs only on the western Himalayas northward across the central Asiatic highland to Dzungaria. Plants identified by some authors as simply *P. rhinanthoides* are actually referable to var. *labellata*. Among the specimens named by various authors as var. *labellata* some should be more precisely assigned to var. *tibetica*. The var. *labellata* occurs from the Himalayas to northwestern Yunnan, Sikang, northern Szechuan, Kansu, Shensi, and Chahar. The var. *tibetica* is localized in northwestern Yunnan and adjacent southeastern Sikang. The differentiating characters of the varieties in China are as follows:

Key to the Chinese Varieties

A. Beak not longer than the hood of the galea, usually simple-curved; lower lip 14-17 mm. wide. .... 218a. *P. r. typica*
AA. Beak longer than the hood of the galea, incurved but distally often also upcurved; lower lip 17-20 mm. wide.
  B. Bracts and upper petioles glabrate to slightly villose; lower lip glabrous on the margins. .... 218b. *P. r. labellata*
  BB. Bracts and upper petioles more villose; lower lip ciliate on the margins. 218c. *P. r. tibetica*

218a. **Pedicularis rhinanthoides** typica

Pedicularis rhinanthoides Schrenk var. *typica* Prain, in Journ. As. Soc. Beng., 58 (2): 272, 1889; in Ann. Bot. Gard. Calcutta, 3: 110, 1890; Limpricht, in Repert. Sp. Nov., 20: 248, 1924.

Pedicularis rhinanthoides Schrenk ex Fisch. & Mey., Enum. Pl. Nov. Schrenk, 1: 22, 1841; Benth., in DC. Prodr., 10: 565, 1846; Ruprecht, in Mem. Acad. St. Pétersb., VIII: 14 (4): 63, 1869; Marquand, in Journ. Linn. Soc. Bot., 48: 213, 1929. The type was from Dzungaria: "In alpibus Alatau ad fl. Baskan decerpta d. 29 Junii m. [*1840, A. Schrenk*]." Isotypes are in the herbaria of the Academy of Natural Sciences of Philadelphia and the New York Botanical Garden. Several other references to this species by later authors, for plants from Kansu and Sikang are apparently referable to var. *labellata* instead of the typical form.

Moist places at altitudes of 3000 to 5000 meters from the western Himalayas northward to Dzungaria and Turkestan. Flowers purple. Flowering in July and August.

Several specimens seen from Turkestan and Dzungaria, none from the Chinese territories.

218b. **Pedicularis rhinanthoides labellata** (Jacquemont) Prain Plate 10, fig. 177.

Pedicularis labellata Jacquem., Voy. dans l'Inde, Bot. 118, pl. 123, 1844; Maxim., in Bull. Acad. St. Pétersb., 24: 54, 1878; 32: 532, 1888; in Mél. Biol., 10: 83, 1878; 12: 792, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 27: 792, 1888; Bonati, in Notes Bot. Gard. Edinb., 5: 79, 1911; 7: 81, 1912; Limpricht, in Repert. Sp.

Nov. Beih., 12: 483, 1922; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 33, 1933; Pai in Contr. Bot. Inst. Nat. Acad. Peiping, 2: 213, 1934; Hand.-Maz., Symb. Sin., 7: 863, 1912. The type was from Tibet: "In humidis ab Yurpo ad Lamoutche, Gatang-Ghauti; 18,300 ped. angl. [Victor Jacquemont in 1828-32]."

Pedicularis rhinanthoides Schrenk var. *labellata* (Jacquem.) Prain, in Journ. As. Soc. Beng., 58 (2): 272, 1889; in Ann. Bot. Gard. Calcutta, 3: 110, 1890; Bonati, in Bull. Herb. Boiss II, 7: 542, 1907; in Notes Bot. Gard. Edinb., 17: 71, 1929; Limpricht, in Repert. Sp. Nov., 20: 248, 1924.

Pedicularis biondiana Diels, in Engl. Jahrb., 29: 571, 1900; 36, Beibl., 82: 96, 1905. The type was from Shensi: "N[Nord-District] Gipfel des Tcai pa shan (Gi[raldi] 1210 fl. Aug.:)." This was first given as a synonym by Limpricht (l.c., 1920), who cited *Giraldi* 1210.

"*Pedicularis rhinanthoides*" *sensu* Bonati, in Bull. Herb. Boiss., II, 7: 542, 1907; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 218, 1934; Walker, in Contr. U. S. Nat. Herb., 18: 659, 1941; non *P. rhinanthoides typica.*

Moist places in high alpine valleys at altitudes of 3000 to 4500 meters, from the western Himalayas eastward to Yunnan, Sikang, Kansu, Shensi, and Chahar. Flowers purple. Flowering from July to September.

Western China: no precise locality, *Wilson* 4243 (UCLA).

Chahar: Hsiao Wutzeshan, *T. P. Wang* 756 (NYBG), *Meyer* 1193B (GH, NYBG).

Shensi: Miao Wang Shan, *Giraldi* 5550 (UCLA).

Kansu: Tangut, *Przewalski* s.n. (UCLA); Tetung, *Przewalski* s.n. (ANSP); en route to Tebbu land, southwest of Minshan, *Rock* 13098 (ANSP, GH, USNH); T'ao River basin, entrance to Tsaluku valley from Kajaku, *Rock* 13164 (ANSP, GH, NYBG); near Pingfan, *Ching* 471 (ANSP, UC, USNH); Lan Ze Cheon K'ou, near Sining, *Ching* 580 (USNH).

Chinghai: between Radja and Jupar range, south of Woti la, north of Radja, *Rock* 14403 (GH, NYBG, USNH).

Sikang: Tatsienlou, *Soulié* 556 (ANSP, NTU, UCLA), 1088 (NYBG); Latra, Tatsienlou, *Soulié* 2859 (ANSP); Tongolo, *Soulié* 1894 (UCLA); Baurong to Tachienlu, via Hadjaha, *Stevens* 310 (CM); Lianghokow, *Wang & Wen* 647 (AA).

Yunnan: Lan-kong, *Delavay* 2621 (ANSP, NYBG, UCLA).

This variety is geographically distinct from the typical form which occurs in the northwest. It can be distinguished from the latter by its longer and more out-curving beak as well as its wider lower lip. In these characters is is similar to var. *tibetica,* but the latter has generally more villose bracts and ciliate-margined lower lip.

218c. **Pedicularis rhinanthoides tibetica** Bonati

Pedicularis rhinanthoides Schrenk var. *tibetica* Bonati, in Bull. Soc. Bot. Genève, II, 5: 113, 1913; Limpricht, in Repert. Sp. Nov., 20: 249, 1924. The type: "Tsé kou [Monbeig] n° 107," is in the Bonati Herbarium and will pass to the Academy of Natural Sciences of Philadelphia, with isotype at the University of California at Los Angeles. The locality is northwestern Yunnan.

Pedicularis labellata Jacq. var. *tibetica* Hand.-Maz., Symb. Sin., 7: 863, 1936. Based on the above.

Alpine meadows at altitudes of 3000 to 4000 meters in northwestern Yunnan and southeastern Sikang. Flowers purple. Flowering from June to early September.

Sikang: Mountains of Kulu, *Rock* 18086 (ANSP, USNH); Tsarung, mountains west of the Kaakerpo, Dokerla and Yundshi, *Rock* 23147 (CM, MBG, NYBG, UC, UP, USNH); Mt. Siga, west of Karadi, *Rock* 23863a[11] (NYBG, UC, UP); Tatsienlu, *Cunningham* 89 (RBGE), 243 (RBGE).

YUNNAN: no precise localities, *Monbeig* s.n. (ANSP, UCLA), *Forrest* s.n. (UCLA), *Yü* 6537 (AA), 9252 (AA), 12284 (AA), 12353 (AA); Tse-kou, *Monbeig* 107 (ANSP, NTU, UCLA); Mekong-Salween divide, *Forrest* 14165 (ANSP), 14468 (UCLA); Sila, Mekong-Salween divide, *Yü* 19038 (AA), 22195 (AA), 22392 (AA), 22799 (AA), 23207 (AA); Chiming, Salween-Kiukiang divide, *Yü* 22070 (AA); Sewalongba, Mekong-Salween divide, *Yü* 22526 (AA), 22676 (AA); Huann-fu-ping, Atuntze, *C. W. Wang* 68827 (AA); Chawchi Pass, *Farrer* 1898 (RBGE).

This variety is close to var. *labellata* especially in the long and somewhat outcurved beak and the wider lower lip. It has, however, more sharply cut pinnae, more slender beak, more villose bracts, and particularly a ciliate-margined lower lip.

219. **Pedicularis cyclorhyncha** sp. nov. Plate 11, fig. 178.

Planta elata, ad 4 dm. alta, inflorescentiis exceptis glabra; caulibus rectis, singulis, simplicibus vel ad basim ramosis, aliter simplicibus; foliis caulinis alternis, inferioribus longe petiolatis, petiolis ad 7 cm. longis, tenuibus, leviter alatis, superioribus breviter petiolatis vel subsessilibus, laminis linearibus vel lanceolatis, 2.2-6 cm. longis, 7-9 mm. latis, acutis vel obtusis, pinnatisectis, segmentis utrinsecus 10-12, ovatis acutis, 3-4 mm. latis, pinnatifidis, denticulatis, basi latis, adnatis; inflorescentiis terminalibus racemosis ad 10 cm. longis, pubescentibus, floribus superioribus densis, inferioribus laxis; bracteis foliaceis, subsessilibus, oblongis, pinnatisectis vel profunde pinnatifidis, calycem superantibus; pedicellis ad 5 mm. longis, gracilibus, erectis; calyce ovoideo-cylindrico, circiter 1.2 cm. longo, sparse pubescente, 5-nervo, parce reticulato, antice vix fisso, 5-dentato, dentibus inaequalibus, dente posteriore minore, ovato, serrato, caeteris ovatis profunde serratis, saepe 2-3-dentatis; corollā purpureo-rubrā, circiter 2.5 cm. longā: tubo erecto, calycem duplo superante, externe parce pubescente, superne subdilatato, curvato; galeā plus minusve horizontale, in semi-circulum curvatā, apice in rostrum gradatim productā; rostro circiter 8 mm. longo, filiformi, in semi-circulum incurvato, apice integro; labio inferiore circiter 1.1 cm. longo et 2 cm. lato, margine subtiliter ciliato, 3-lobato, lobis late rotundatis, subaequalibus; staminibus ad apicem tubi insertis, filamentis anterioribus superne villosis, posterioribus glabris; stylo subexserto; capsulis ignotis.

Type, on open moist pasture, Ah-s-chi, northwest of Likiang, Yunnan Province, collected in flower, June 29, 1939, by R. C. Ching, No. 20951; holotype in the herbarium of the Arnold Arboretum. Flowers crimson. Only collection seen.

This species is strongly characterized by the galea being curved at the base, and together with the strongly incurved beak this forms a complete circle. The calyx is only slightly cleft anteriorly and with 5 serrate teeth, the lateral ones often 2-3-lobed to the base, resulting in some flowers seeming to be as many as 9-11-dentate. The relationship of this species is probably with *P. rhinanthoides.* The latter, however, differs in the calyx-structure as well as in the galea bending only in the middle and the beak often curving outward. *P. rhinanthoides* is currently interpreted as a comprehensive species but the marked difference of this new species does not permit it to be included in its concept. This new species also suggests relationship with the Megalanthae, a series primarily of the eastern Himalayas.

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[11] The number *Rock* 23863 consists of two elements which I designate as *a* and *b*; *a* is *P. rhinanthoides tibetica* in NYBG and UC; while *b* is *P. cephalantha szetchuanica* Bonati in UP. The sheet in USNH contains both.

Series 60. Amplitubae ser. nov.

Perennial, medium-sized plant, villose; roots fascicled, filiform; stem single, rigid, flexuous, few-leaved; leaves radical and cauline, the radical long-petiolate, linear-oblong, pinnatifid, the segments many, oblong, broadened at base, crenately pinnatifid, denticulate, the cauline leaves few, alternate to subopposite, similar to the radical but smaller and shorter petiolate; inflorescences short-racemose, the upper flowers compact, the lower lax; pedicels erect; bracts foliaceous; calyx cylindric, slightly pubescent, slightly reticulate distally, cleft anteriorly, 5-dentate, the teeth unequal, the posterior smaller, dentate, the others very broad, deeply incised-dentate; corolla purple, the tube 2½ times as long as the calyx, erect, rather broad, slightly hairy; galea falcate, with a distinct reflexed tooth on either side of the lower margin, the beak subfiliform, straight, slightly bifid at the apex; stamens inserted at the throat of the tube, the filaments hairy distally, the posterior ones sparsely so; stigmas slightly exserted.

One species in northwestern Yunnan (Map 34).

In corolla-structure, except the very long tube, this series resembles the Oliganthae. The calyx, however, differs in having five teeth. The leaves are very similar to those of *P. filicula* of the Asplenifoliae and *P. macrorhyncha* of the Macrorhynchae. It may be that the relationship of this series is with some species of the Asplenifoliae or the allied series Paucifoliatae. The development of a long corolla-tube and of a more pronounced cleft of the calyx is the outstanding difference from those short-tubular species.

220. Pedicularis amplituba sp. nov. Plate 11, fig. 179.

Planta perennis, ad 2 dm. alta; radicibus multis filiformibus, longis; caulibus singulis simplicibus, pauce foliatis villosis rigidibus flexuosis adscendentibus; foliis radicalibus caulinisque, radicalibus multis longe petiolatis, ad 13 cm. longis, petiolis ad 6 cm. longis, gracilibus villosis, laminis lineari-oblongis, obtusis vel acutis, ad 7 cm. longis 1.7 cm. latis, subchartaceis, supra glabratis, infra ad costas villosis, pinnatisectis, segmentis utrinsecus 12-16 oblongis, obtusis, basi latis, adnatis, superioribus inferioribusque paulo minoribus, mediis majoribus, 4-5 mm. latis, crenato-pinnatifidis, lobulis denticulatis; foliis caulinis saepe 2 vel 4 suboppositis vel alternis, radicalibus similibus at minore et breviter petiolatis; inflorescentiis terminalibus breviter racemosis ad 6 cm. longis, floribus superioribus compactis, inferioribus laxis; bracteis foliaceis, petiolatis, pinnatifidis, calyces superantibus; pedicellis ad 1 cm. longis, erectis, villosis; calyce cylindrico, circiter 1.2 cm. longo, extus pubescente, superne parce reticulato, antice fisso, 5-dentato, dentibus inaequalibus, dente posteriore minore, ovatis, acuminatis, dentatis, dentibus lateralibus late palmatis, basi valde constrictis, superne profunde inciso-dentatis, lobis denticulatis, dentibus posterioribus saepe paulo minoribus; corollā purpureo-roseā, 3.5 cm. longā: tubo longo, erecto, circiter 2.8 cm. longo et 2.5 mm. lato, calycem 2½-plo superante, externe parce pubescente; galeā falcatā, in parte horizontali margine inferiore cum dente distinctissimo inflexā, apice in rostrum subabrupte productā; rostro subfiliformi, recto, circiter 4 mm. longo, apice paulo bifido; labio inferiore superius paulo superante, margine ciliato, 3-lobato, lobis rotundatis, subaequalibus, lobo medio subporrecto; staminibus ad apicem tubi insertis; filamentis superne villosis, posterioribus parcis; stylo subexserto; capsulis ignotis.

Type, on rocky slopes at an altitude of 3460 meters, Chengkang Snow Range, northwestern Yunnan, collected in flower, July 24, 1938, by T. T. Yü, No. 16939; holotype in the herbarium of the Arnold Arboretum. Flowers purplish pink. Only collection seen.

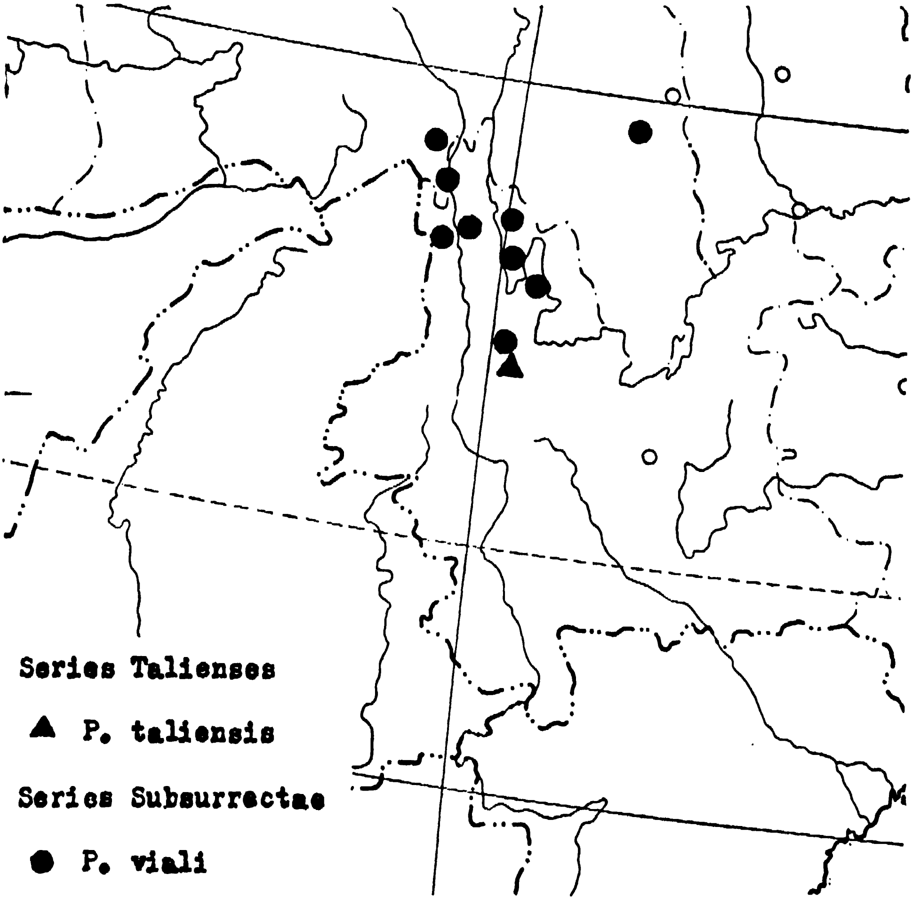
In the presence of a distinct reflexed tooth on either side of the lower margins of the galea, this species suggests relationship with the Oliganthae, but the 5-dentate calyx and the long corolla-tube are very different from the latter. The general habit is also quite dissimilar. The foliage resembles particularly that of *P. filicula* but otherwise there is little suggestion of relationship. This new species is also characterized by the long and rather broad corolla-tube in association with a straight beak.

Series 61. Talienses ser. nov.

Plant to 2 dm. tall; roots simple, vertical, thick, with fibrous branches; stem erect, simple, delicately grooved, with longitudinal lines of hairs, few- and short-branched below and above; leaves mostly cauline, rather small, petiolate, glabrous, pinnatisect, the segments 4-6 on each side, oblong, narrowed at base, shallowly pinnatifid, cartilaginous-denticulate; flowers axillary, scattered, short-pedicellate; calyx campanulate, short, hairy externally, not reticulate, not cleft anteriorly, with 5-7 small sometimes obscure triangular and entire teeth; corolla pale rose, the tube short, galea produced into a short conical beak, the beak horizontal, straight; lower lip glabrous on the margins, 3-lobed, the lobes rounded, the middle lobe smaller and more distad; staminal filaments very sparsely hairy; styles included; capsules unknown.

One species in northwestern Yunnan (Map 35).

This series is characterized by the axillary scattered, more or less short-pedicellate flowers with an uncleft calyx bearing 5-7 entire teeth and a straight corolla produced into a short conical beak. The relationship is probably with the Longipedes and their allies. It resembles the Longipedes in the scattered axillary flowers, the campanulate, non-cleft calyx, and the general corolla structure. It differs, however, in the short pedicels and in the obscure, deltoid and entire calyx-teeth.



Map 35.—Distribution of the series Talienses and Subsurrectae.

221. **Pedicularis taliensis** Bonati Plate 11, fig. 180.

Pedicularis taliensis Bonati, in Notes Bot. Gard. Edinb., 5: 87, pl. 74, 1911; 7: 242, 1912; Limpricht, in Repert. Sp. Nov., 20: 247, 1924. The type was from northwestern Yunnan: "'Plant of 4-10 inches. Flowers pale rose. Grassy situations on the margins of pine forests on the eastern flank of the Tali Range. Lat. 25° 40′ N. Alt. 9-11,000 ft. July-August 1906.' G. Forrest. No. 4500." An isotype in the Bonati Herbarium will be divided between the Academy of Natural Sciences of Philadelphia and the University of California at Los Angeles.

Alpine meadows at altitudes of about 2750 to 3350 meters, in northwestern Yunnan. Flowers pale rose. Flowering in July and August.

Yunnan: eastern flank of the Tali Range, *Forrest* 4500 (ANSP, UCLA); no precise locality, *Forrest* 29936 (ANSP).

A rather delicate species resembling somewhat *P. souliei* in habit. However, the short uncleft calyx with its obscure 5-7 teeth, the short corolla-tube and the short and conical beak are different from those of all other species of the series Oxycarpae to which Limpricht assigned the species. It is especially distinct in the more or less scattered axillary flowers.

Series 62. Subsurrectae

Subsurrectae Prain, in Ann. Bot. Gard. Calcutta, 3: 80, 1890.

Tall, erect plants; stems simple or sometimes shortly and slenderly branched above; slightly pubescent; leaves cauline, alternate, long-petiolate, ovate-lanceolate, pinnatisect, the rachis dentate-winged above, the segments remote, pinnatifid, dentate; inflorescences long-racemose, lax, with small short-pedicelled flowers; bracts small, narrow; calyx glabrous to sparsely pubescent, 5-dentate, the teeth triangular, acute; corolla whitish with rose to purple galea, the tube only slightly longer than the calyx, the galea inflated-convex, the lower lip small and short, scarcely ⅓ as long as the upper, 3-lobed, the median lobe ovate, distad, the lateral ones slightly broader; filaments glabrous.

One species in northwestern Yunnan, Sikang, and Upper Burma (Map 35).

This series consists of a single species which is very strikingly characterized by its small and short lower lip and slender ascending beak. Probably it is related to the series Recurvae.

222. Pedicularis viali Franchet Plate 11, fig. 181.

Pedicularis viali Franch. ex Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 219, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 85, 1911; 7: 242, 1912; 15: 158, 1926; 17: 63, 1929; Limpricht, in Repert. Sp. Nov., 20: 233, 1924; 23: 336, 1927; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 224, 1934; Hand.-Maz., Symb. Sin., 7: 857, 1936. The type was from: "Yunnan: in woods above Yentzehay (Delavay, 3378, ex Franchet)." Isotypes are at the New York Botanical Garden, the United States National Museum, and the University of California at Los Angeles.

In conifer forests or on grassy slopes at altitudes of about 3300 to 4300 meters in northwestern Yunnan, Sikang, and Upper Burma. Flowers whitish with rose to purple galea. Flowering from May to August.

SIKANG: Mount Konka, Risonquemba, Konkaling, *Rock* 16799 (ANSP, USNH); Tsa-wa-rung, Chi-na-tung, *C. W. Wang* 65345 (AA), 65391 (AA).

YUNNAN: Yen-tze-hay, *Delavay* 3378 (ANSP, NTU, NYBG, UCLA, USNH); eastern slopes of the Tali Range, *Forrest* 4498 (ANSP, NTU, UCLA); mountains southeast of the Yangtze bend, *Forrest* 10480 (RBGE); Tong Shan in the Yangtze bend, *Forrest* 10870 (ANSP); Chungtien Plateau, *Forrest* 13026 (ANSP, UCLA); Ka-gur-pw, Mekong-Salween divide, *Forrest* 14369 (UCLA); Yakolo, eastern slopes of Mount Dyinaloko, northern peak of the Likang Snow Range, *Rock* 10430 (ANSP, USNH); Wei-si District, Yeh-chih, *C. W. Wang* 68556 (AA); A-tun-tze, *C. W. Wang* 69927 (AA); Mekong-Salween divide, Sila, *Yü* 22406 (AA); southeastern Chungtien, Ta-cha-tse-ka near Hsiao Chungtien, *Feng* 1888 (AA); southeastern Chungtien, between Pei-lu-shan and Anangu, *Feng* 2016 (AA); no data, *Yü* 9508 (AA), 12709 (AA), *Forrest* 28777 (ANSP).

A species strongly characterized by the very short lower lip. The lip is only one-third as long as the galea (with its beak). The beak is long and slender and somewhat ascending. The stem may be either simple or shortly and slenderly branched above.

SECTION XVII. MACROSTACHYS

Low or usually tall plants; stems erect, simple or branched; leaves radical and cauline or usually all cauline, pinnatisect to rarely deeply pinnatifid, the segments pinnatifid and serrate; inflorescences in long terminal racemes or spikes, the flowers usually laxly arranged, very numerous; pedicels long or short; calyx campanulate to cylindric, cleft or not anteriorly, 3-5-dentate, the teeth equal to unequal, entire to serrate; corolla with the tube erect, slightly longer than to twice as long as the calyx; galea produced into a conical to filiform beak; lower lip usually with a smaller middle lobe, distad or not.

This section is related to Rhizophyllum and Botryantha, but is characterized by the long, many-flowered inflorescences, and the leaves mostly all cauline. The range of the section is in northwestern and southwestern China.

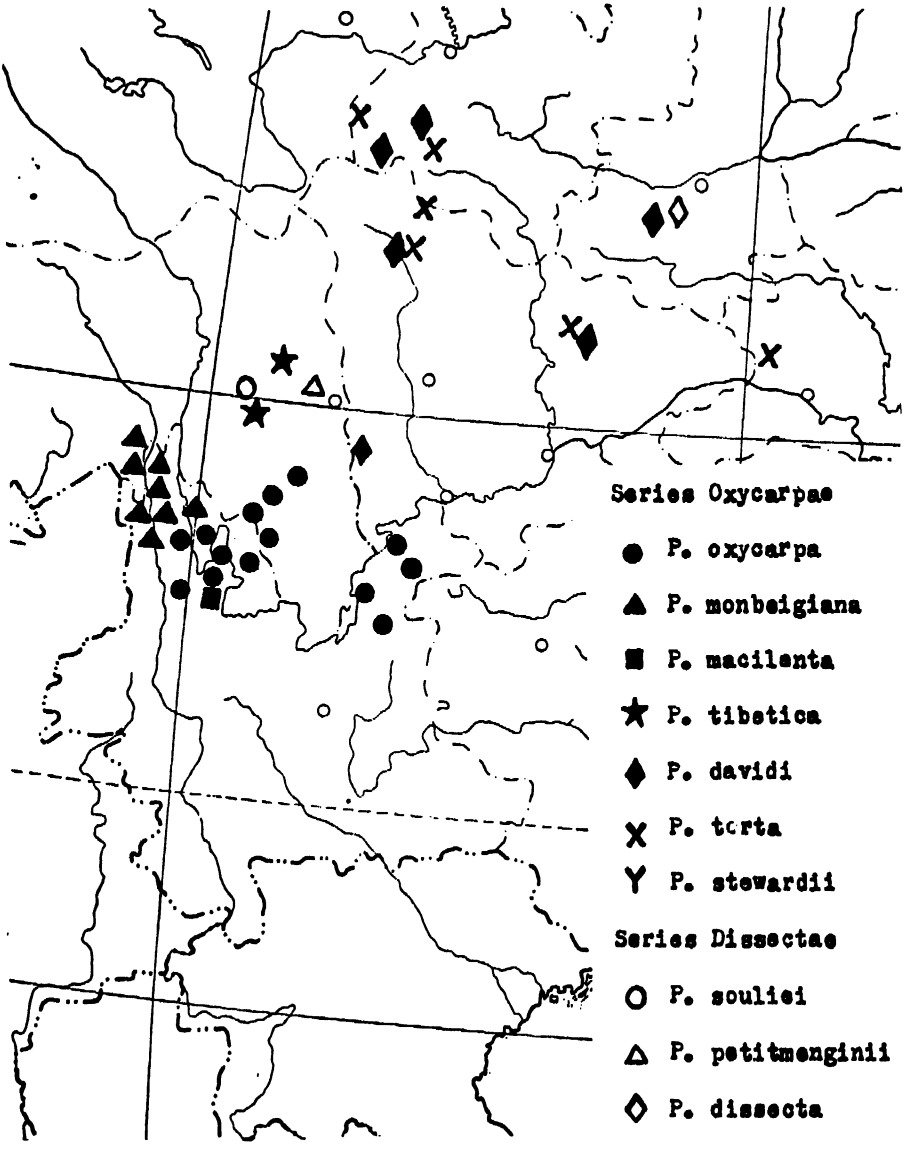
Series 63. Oxycarpae

Oxycarpae Prain, in Ann. Bot. Gard. Calcutta, 3: 74, 1890.

Erect; stems simple or branching near the base; leaves radical and cauline or all cauline, alternate, petiolate, oblong to lanceolate, pinnatisect to deeply pinnatifid, the segments pinnatifid and dentate; inflorescences in more or less long terminal racemes or spikes, the lower flowers laxly arranged; bracts foliaceous, petiolate, usually trilobed, dissected; calyx membranaceous, campanulate to cylindric, reticulate or not, cleft anteriorly, 3-5-dentate, the teeth equal to unequal, entire to dentate; corolla pink to purple or yellow proximally and purple distally, the tube erect, longer than the calyx, usually puberulous externally, scarcely enlarged distally; galea twisted or not, produced into a long filiform beak usually bending and sometimes sigmoid; lower lip 3-lobed, ciliate or rarely glabrous on the margins, the lobes rounded, the middle smaller, distad or not; stamens inserted at the middle or on the upper half of the tube; the filaments hairy, rarely glabrous; styles included or the stigmas scarcely exserted; capsules long, acute to acuminate, compressed, long-exserted from the calyx.

About 7 species in western China from Kweichow to Yunnan, Sikang, Szechuan, western Hupeh, southern Shensi, and southern Kansu (Map 36).

When Prain established the series he had only 4 species, *P. torta*, *P. davidi*, *P. oxycarpa*, and *P. macilenta*. Later Bonati (in Bull. Soc. Bot. France, 57, Mém. 18: 14, 1910) included in his key several long-pedicellate axillary-flowered species like *P. petitmenginii* and *P. soulici*. These species also differ from other species of the series in the short fruit. They are only remotely related to the Oxycarpae and are here removed to form a separate series. *P. kialensis* and *P. taliensis*, included in this series by Limpricht, the former in the Megalanthae by Bonati, are distinct species of their own and are very different from the Oxycarpae. They are also now being segregated into separate series.



Map 36.—Distribution of the series Oxycarpae and Dissectae.

The Oxycarpae, as Prain originally defined the series and as here accepted, comprise species with rather long terminal racemes or spikes with either twisted or non-twisted galea. The corolla-tube is about twice as long as the calyx and the beak is long-filiform and often curved or coiled. Their nearest relatives are clearly the Oliganthae.

Key to the Species

A. Galea or beak not twisted to one side (occasionally twisted in a few flowers of *P. monbeigiana*); beak straight or slightly bending; staminal filaments sparsely hairy or glabrous.

B. Flowers larger, about 1.5 cm. or more long; galea clearly crested; lower corolla-lip ciliate on the margins; staminal filaments sparsely hairy.

C. Plant about 2-4 dm. tall; stems branching at base; leaves and bracts pinnatisect, the former to 8 cm. long, the latter shorter; calyx glabrous, the teeth 3, equal, entire; corolla white with purple beak, the beak bending proximally, pointing downward. .... 223. *P. oxycarpa*

CC. Plant 5 dm. or more tall; stems simple throughout; leaves larger, to 15 cm. or more long, deeply pinnatifid; bracts longer than the leaves, pinnatifid; calyx sparsely hairy, the teeth 3-5, unequal, the posterior small, entire, the lateral ones 2 or 4, broad and dentate, sometimes the two anterior-most smaller or absent; corolla purplish throughout, the beak pointing forward, straight proximally, bending distally. 224. *P. monbeigiana*

BB. Flowers smaller, about 1-1.2 cm. long; galea not crested; lower corolla-lip glabrous on the margins; staminal filaments glabrous. .... 225. *P. macilenta*

AA. Galea or beak strongly twisted to one side; beak prominently curved or coiled; staminal filaments more or less densely hairy.

B. Plant low, 1.5 dm or less tall; leaves deeply pinnatifid to nearly pinnatisect, the segments approximate, broadly adnate at base; calyx reticulate, the teeth 5, subequal, all dentate; lower lip of corolla with glabrous margins. 226. *P. tibetica*

BB. Plants tall, 2 dm. or more in length; leaves pinnatisect, the segments remote, narrowed at base; calyx scarcely or not reticulate, the teeth 3, equal and all dentate or unequal with the posterior entire to subentire and the lateral dentate; lower lip of corolla ciliate on the margins.

C. Plants with stems unbranched above or sparsely and shortly once-branched; leaves mostly basal, the segments over 10 on each side; inflorescence long, 10-15 cm. or more in length; beak long and slender, 6-7 mm. or more long, distinctly coiled.

D. Calyx glabrous, not reticulate, the teeth equal, oblong, narrow, entire; corolla purple. .... 227. *P. davidi*

DD. Calyx slightly hairy, slightly reticulate distally, the teeth unequal, the posterior oblong, subentire, the lateral ovate, broad, distinctly serrate; corolla yellow. .... 228. *P. torta*

CC. Plant with stem freely and repeatedly long-branching above; leaves all cauline, the segments 5-7 on each side; inflorescences short, scarcely 3 cm. long; beak shorter, scarcely 5 mm. long, bending, not coiled. 229. *P. stewardii*

223. Pedicularis oxycarpa Franchet Plate 11, fig. 182.

Pedicularis oxycarpa Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 540, fig. 19, 1888; in Mél. Biol., 12: 804, fig. 19, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 218, 1890; Diels, in Bot. Jahrb., 29: 572, 1900; Bonati, in Notes Bot. Gard. Edinb., 5: 80, 1911; 7: 132, 1912; 8: 38, 1913; 15: 163, 1926; Limpricht, in Repert. Sp. Nov., 20: 247, 1924; Pai, in Contr. Bot. Inst. Nat. Acad. Peiping, 2: 215, 1934; Hand.-Mazz., Symb. Sin., 7: 862, 1936. The type, "Yunnan, prope Lankong, monte Hee-Chan-Men (Delavay! in herb. Paris.: 'fleurs bigarrées de blanc et de rose'), Ex sicco labium albidum (album?) galea atra (rosea?)," has not been seen.

Alpine meadows at altitudes of 3000 to 4360 meters in northwestern Yunnan and southeastern Sikang. Flowers white with purple galea. Flowering from May to October.

Western China: no precise locality, *Wilson* 4260 (B).

Yunnan: Fang yang tchang, Mo so yn, *Delavay* 3064 (B, USNH); Tong-tchounan, *Maire* 3998 (ANSP, NTU, UCLA), 6368 b (ANSP, NTU, UCLA), 7423 (ANSP, NTU, UCLA); *Ducloux* 692 (ANSP, NTU, UCLA); San-kia, Kiao-Kia, *Ducloux* 901 (ANSP, UCLA); Likiang, *Schneider* 1817 (GH, USNH); eastern flank of the Likiang Range, *Forrest* 2450 (ANSP, NTU), 6076 (ANSP, UC); Gan Hai Tze, western slopes of Likiang Snow Range, *Rock* 4145 (NYBG, USNH); eastern slopes of Likiang Snow Range, *Rock* 4554 (USNH), 11442 (USNH); between Likiang, Youngning and Youngpei, *Rock* 5168 (ANSP, GH, UC, USNH); eastern slopes of Likiang Snow Range, Mt. Satseto, *Rock* 24909 (NYBG, UC, UP); Young-shan District, *Tsai* 51049 (AA); Yi-liang District, *Tsai* 52175 p.p. (AA); Lan-ping District, *Tsai* 53779 (AA); southern Chungtien, Hsiao Chungtien, *Feng* 1391 (AA); Likiang Snow Range, *Yü* 15338 (AA), *Ching* 30288 (AA), 30520 (AA); Gan-hai-tze, northeast of the Likiang Snow Range, *Ching* 20992 (AA), 21292 (AA); no precise localities, *Tsai* s.n. (AA), *Yü* 6244 (AA), 6862 (AA), 11670 (AA), 12605 (AA).

Sikang: Muli, *Ward* 4297 (RBGE), 4566 (RBGE), 4841 (RBGE); Mount Mitzuga, west of Muli Gomba, *Rock* 16507 (ANSP, USNH); mountains between the Litang and Yalung Rivers, between Muli Gomba and Baurong and Wa-Erh-Dje, *Rock* 16643 (ANSP, USNH); mountains of Kulu, *Rock* 18020 (ANSP, GH, UC, USNH), 18084 (ANSP, USNH); Kaushu shan on trail to Leirong, southwest of Muli, *Rock* 24102 (NYBG, UC, UP); Muli, Gu-ma-den, *Yü* 7738 (AA); Muli, Kulu, *Yü* 14247 (AA).

A species readily distinguished by its three entire calyx-teeth. In this character it resembles *P. davidi* but the latter has a twisted beak while in *P. oxycarpa* the galea and the beak are not twisted.

224. **Pedicularis monbeigiana** Bonati Plate 11, fig. 183.

Pedicularis monbeigiana Bonati, in Bull. Soc. Bot. Genève II, 5: 112, 1913; in Notes Bot. Gard. Edinb., 17: 86, 1929; Limpricht, in Repert. Sp. Nov., 20: 246, 1924; Hand.-Maz., Symb. Sin., 7: 862, 1936. The type was from: "Yunnan occidental, region de Oui-Si (Monbeig)." A specimen of *Monbeig* s.n. from Kew Herb., bearing no field data, is in the Bonati Herbarium, and will pass to the University of California at Los Angeles. Another specimen, *Monbeig* 72, June 1912, Tseku, from the Edinburgh Herbarium, is also in the Bonati Herbarium; this will pass to the Academy of Natural Sciences of Philadelphia. It may be an isotype, as Bonati originally mentioned that Monbeig's plant received by him from Edinburgh was collected in 1912 in the region of Tseku.

Alpine meadows at altitudes of 3000 to 4200 meters in northwestern Yunnan and adjacent Sikang. Flowers rose with dark beak. Flowering in July and August.

Yunnan: no precise locality, *Monbeig* s.n. (UCLA); Tseku, *Monbeig* 72 (ANSP); northern flank of the Shweli-Salween divide, *Forrest* 9028 (UCLA); Mekong-Salween divide, *Forrest* 14648 (ANSP); between Salween and Irrawadi, near Tschiangschel, *Handel-Mazzetti* 9235 (GH); between Salween and Irrawadi near Tseku, *Handel-Mazzetti* 9892 (USNH); Mekong-Salween divide, mountains of Nakala, east of Yuragan, *Rock* 23126 (UC, UP), 23439 (UP); Che-tse-lo, *Tsai* 54148 (AA), 58002 (AA), 58278A (AA); Atuntze, *C. W. Wang* 64818 (AA); Lung-pan-la, *C. W. Wang* 67198 (AA); Wei-si District, Yeh-chih, *C. W. Wang* 68531 (AA); Chungtien Plateau, *Yü* 13624 (AA); Parolaka, Salween-Kiukiang divide, *Yü* 20629 (AA); Chiming, Salween-Kiukiang divide, *Yü* 22068 (AA); Sila, Mekong-Salween divide, *Yü* 22323 (AA), 22405 (AA); Sewalongba, Mekong-Salween divide, *Yü* 22504 (AA), 22541 (AA).

Sikang: Tsarung, Mt. Wuli-la, high mountain east of the Salween River and north of Alulaka, *Rock* 22372 (NYBG, UC, UP); Yundshi mountains, *Rock* 23594 (NYBG, UC); Chawchi Pass, *Farrer* 1861 (RBGE).

A species readily distinguished by its large size, its single, simple, robust stem, and its large, deeply pinnatifid leaves. Its corolla-structure most nearly approaches that of *P. oxycarpa*, but in *P. monbeigiana* the corolla is larger with the beak pointing forward and with the middle lobe of the lower lip relatively large. The galea is occasionally twisted. The calyx-teeth as described by Bonati are 5. Handel-Mazzetti noted that all the specimens he collected have three teeth. Among the large series examined, it is found that the number of calyx-teeth varies in this species. The four lateral teeth may be all present and of equal size, or two of the anterior may be reduced in size or entirely absent. Handel-Mazzetti also mentioned his 9892 as having white flowers. The label of *Yü* 22504 cited above notes, " flowers pinkish white " and that of *Tsai* 58002, " flowers white." In all other specimens the flowers are labelled pink, rose or purple. The capsules as compared with others of the series are shorter and less compressed.

225. **Pedicularis macilenta** Franchet Plate 11, fig. 184.

Pedicularis macilenta Franch. ex Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 212, 1890; Limpricht, in Repert. Sp. Nov., 20: 247, 1924; Hand.-Maz., Symb. Sin., 7: 863, 1936. The type was from " Yunnan: in humid localities on the slopes of Mount Yentzehay (Delavay, 1888, ex Franchet)." An isotype is in the Bonati Herbarium. It is numbered *Delavay* 3698, from the Paris Museum. It will divide between the Academy of Natural Sciences of Philadelphia and the University of California at Los Angeles.

In northwestern Yunnan. Flowers white with reddish beak.

YUNNAN: Yentzehay, *Delavay* 3698 (ANSP, UCLA).

This species is closely related to *P. oxycarpa*. It differs from the latter in having shorter inflorescences, a hairy calyx with its 2 lateral teeth dentate, a non-cristate galea with a more or less straight and horizontal beak, glabrous margins of the lower lip, and glabrous filaments. The filaments are attached to about the middle of the corolla-tube while those of *P. oxycarpa* extend to the upper third of the tube.

226. **Pedicularis tibetica** Franchet Plate 11, fig. 185.

Pedicularis tibetica Franch., in Bull. Soc. Bot. France, 47: 24, 1900; Bonati, in Bull. Herb. Boiss. II, 7: 542, 1907; Limpricht, in Repert. Sp. Nov., Beih. 12: 483, 1922; in Repert. Sp. Nov., 20: 246, 1924; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 222, 1934. The type, " Se-tchuen, aux environs de Tongolo, à Kajilakro sur les pelouses sèches (Soulié, n. 598)," has not been seen. *Soulié* 362, a topotype, is in the Bonati Herbarium, from which it passes to the Academy of Natural Sciences of Philadelphia and the University of California at Los Angeles.

Pedicularis dielsiana Limpricht, in Repert. Sp. Nov., Beih 12: 483, 1922, *non* Bonati 1907. The type, " Ost-Tibet: Dawo, Tal von Lumpu, obershalb des Talschlusses Lartza gegen dem Passgrat Silhä tschem la, 4400–4500 m. [Limpricht] (n. 1988) [in 1914]," has not been seen. Limpricht's type was from Dawo, in Sikang, very near to the type locality, Tongolo, of *P. tibetica*. Limpricht's description does not give, with the exception of the length of the corolla, any measurements. In general it agrees fairly well with *P. tibetica*, and reveals no notable differences. However, Limpricht recognized at the same time *P. tibetica* by citing his 1666 from Tatsienlu. Thus the name is only tentatively reduced to the synonymy of the latter. An examination of the type is necessary for final decision.

Pedicularis limprichtii Fedde, in Repert. Sp. Nov., 18: 122, 1922. Based on *P. dielsiana* Limpricht, *non* Bonati.

Pedicularis ludovici Limpricht, in Repert. Sp. Nov., 20: 247, 1924. Limpricht overlooked the fact that Fedde had previously assigned a name for his *P. dielsiana* Limpricht, *non* Bonati.

In Sikang. Flowers reddish with white spots. Flowering in July.

SIKANG: Tongolo, *Soulié* 362 (ANSP, UCLA); Tsekou, *Soulié* 2853 (ANSP, NYBG, UCLA).

A species with twisted galea like *P. davidi* and *P. torta*, but which is very different from both in habit. It is a much lower plant with deeply pinnatifid to nearly pinnatisect leaves, the segments being relatively broad, approximate, widened and adnate at the base. It also differs in the 5 calyx-teeth and glabrous-margined lower lip. The galea is simply curved instead of somewhat sigmoid.

227. **Pedicularis davidi** Franchet Plate II, fig. 186.

Pedicularis davidi Franch., in Nouv. Arch. Mus. Hist. Nat. Paris II, 10: 67, 1888 (Pl. David. II); Maxim., in Bull. Acad. St. Pétersb., 32: 539, fig. 18, 1888; in Mél. Biol., 12: 803, fig. 18, 1888; Diels, in Bot. Jahrb., 29: 571, 1900; Bonati, in Bull. Herb. Boiss. II, 544, 1907; in Bull. Soc. Bot. France, 54: 185, 1907; Limpricht, in Repert Sp. Nov., Beih. 12: 484, 1922; in Repert. Sp. Nov., 20: 247, 1924, p.p.;[12] Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 33, 1933, p.p.;[12] Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 211, 1934; Hand.-Mazz., Symb. Sin., 7: 862, 1936. The type was from southwestern Szechuan: "Moupine, in pratis humidis regionis altissimae, [David] Fl. Juli 1869." It has not been seen. Maximowicz's illustration was based on this same collection.

"*Pedicularis torta*" *sensu* Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb,. 14: 34, 1933, p.p.; *non* Maxim. Among the specimens cited for that species, *Rock* 12615 is *P. davidi*.

Alpine meadows at altitudes of 2250 to 2350 meters in southwestern Kansu, southern Shensi, and Szechuan. Flowers purple. Flowering from June to August.

KANSU: T'ao River basin, Mt. Hissedzadza, in Hsiaoku gorge, *Rock* 12615 (ANSP, GH, USNH); Upper Tebbu Country, northern Minshan Range, west of main Shimen, *Rock* 13032 (ANSP, GH, NYBG); Siku, *Farrer* 135 (RBGE).

SHENSI: southern Shensi, *Giraldi* s.n. (ANSP, UCLA); southern Shensi, Thae-pei-shan, *Giraldi* 5541 (UCLA).

SZECHUAN: no precise locality, *Henry* 8868 (GH); Tchen-keou-tin, *Farges* s.n. (UCLA); Mount Omei, *Wilson* 5078 (UCLA), *Faber* 184 (NYBG), *Fang* 2887 (GH), 2889 (GH), 2942 (ANSP, GH, USNH), 12940 (AA), *Y. S. Liu* 1252 (AA), *Peng* 118 (AA), *Yin* 131 (AA), *Chiao & Fan* 670 (AA), 817 (AA); Sung-pan District, *Fang* 4350 (ANSP, GH, RBGE, USNH); Juei-she District, *Yü* 1034 (GH).

In the herbarium this species is often confused with two related species, *P. oxycarpa* and *P. torta*. It resembles the first in the 3 entire calyx-teeth but differs in the twisted beak; it resembles *P. torta* in the twisted beak and crested galea but differs in the entire calyx-teeth. In *P. davidi* the beak is twisted at its base and the corolla is purple. In *P. torta* the galea is twisted near its base and the corolla is yellow. *P. oxycarpa* has a more southern range than the two other species.

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[12] Among the collections identified by these authors, some, such as *Wilson* 2278, *Farges* 914 and *Rock* 12448, 12906, belong to *P. torta*.

228. Pedicularis torta Maximowicz Plate 11, fig. 187.

Pedicularis torta Maxim., in Bull. Acad. St. Pétersb., 32: 538, fig. 17, 1888; in Mél. Biol., 12: 801, fig. 17, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 218, 1890; Diels, in Bot. Jahrb., 29: 571, 1900; Limpricht, in Repert. Sp. Nov., 20: 247, 1924; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 34, 1933, p.p.;[18] Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 222, 1934; Hand.-Maz., Symb. Sin., 7: 862, 1936; Walker, in Contr. U. S. Nat. Herb., 28: 660, 1941. The types were from eastern Kansu and northern Szechuan: " Prov. Kansu parte orientali montibus Tchágola, I-tschu-schan et alibi supra limitem sylvarum, prov. Sze-tschuan valle fl. Hei-ho nec non monte Kungála (Potanin fl. fr. immat., 1885)." An isotype from the last mentioned locality labelled: "*Pedicularis torta* Maxim. China. Szetchuan septentr. 25, VII. 1885. Kungala. Legit. G. N. Potanin. Det. Maximowicz," (ex Herb. Petrop.) is in the Bonati Herbarium, whence it passes to the University of California at Los Angeles.

"*Pedicularis davidi*" *sensu* Limpricht, in Repert. Sp. Nov., 20: 247, 1924, p.p.; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 33, 1933, p.p.; *non* Franch. Various specimens such as *Wilson* 2278, *Farges* 914 bis, *Rock* 12448, 12906 have been incorrectly referred to this species.

Alpine meadows at altitudes of 2500 to 4000 meters in southern Kansu, northern and eastern Szechuan and western Hupeh. Flowers yellow with purplish beak. Flowering from June to September.

KANSU: T'ao River basin, near Choni, *Rock* 12448 (GH), 12906 (ANSP, GH, USNH), 12923 (ANSP, GH, NYBG); Labrang, *Ching* 784 (ANSP, GH, UC, USNH).

SZECHUAN: Kungala, *Potanin* s.n. (UC); eastern Szechuan, Tchen-keou-tin, *Farges* s.n. (ANSP), 914 bis (NYBG); Sung-pan District, *Fang* 4015 (ANSP, GH, NYBG, USNH), 4336 (ANSP, GH, RBGE, USNH), 4411 (ANSP, GH, NYBG, USNH).

HUPEH: western Hupeh, *Wilson* 2278 (NYBG, UCLA, USNH).

This species is closely related to *P. davidi* but may be readily distinguished by its incised instead of entire calyx-teeth, corolla yellow with purplish beak instead of purple throughout, and galea twisted near its base instead of beak twisted at its base. The two species have approximately the same range except that *P. davidi* extends a little farther south to Mount Omei in Szechuan where *P. torta* has never been collected.

229. Pedicularis stewardii sp. nov. Plate 11, fig. 188.

Planta elata, 3 dm. vel ultra alta; caulibus rigidis, sparse pubescentibus, copiose ramosis, ramis ramulisque erectis; foliis caulinis alternis brevibus petiolatis, ad 4 cm. longis, petiolis ad 1.5 cm. longis, gracilibus, puberulis, laminis ovatis vel oblongo-ovatis, sparse villosis vel glabris, ad 2.5 cm. longis et 1.3 cm. latis, pinnatisectis, segmentis utrinsecus 4-6, oblongis, remotis, profunde pinnatifidis et dentatis, basi latis adnatis; inflorescentiis terminalibus racemosis brevibus paucifloris, 2-3 cm. longis; floribus 6-7, laxis, circiter 1 cm. longis; pedicellis 1-2 mm. longis, puberulis; bracteis latis, ad 6-7 mm. longis et 5-6 mm. latis, profunde dissectis, basi stipitatis; calyce ovoideo, membranaceo, glabro, circiter 4-5 mm. longo, paucinervo, haud reticulato, antice ad medium fisso, 3-dentato, dente posteriore minore subulato, integro, dentibus lateralibus profunde tridentatis, lobulis integris vel denticulatis; corollā roseā: tubo recto, calycem duplo longiore, externe parce pubescente, superne vix dilatato; galeā profunde tortā, in rostrum productā; rostro circiter 4-5 mm. longò, filiformi, curvato, apice emarginato; labio inferiore 3-lobato, margine ciliato, lobis rotundatis, lateralibus majoribus, lobo medio subporrecto; staminibus ad medium tubi insertis, filamentis sparse villosis; stylo incluso; capsulis oblongis acuminatis valde compressis, circiter 1 cm. longis et 5 mm. latis, basi calyce persistente.

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[18] *Rock* 12615, determined as *P. torta,* is actually *P. davidi.*

Type, exposed mossy rocky slope at an altitude of 2200 meters, Lao Shan, Fan Ching Shan, Kweichow Province, collected in flower and fruit, Oct. 1, 1931, by A. N. Steward, C. Y. Chiao and H. C. Cheo, No. 491; holotype in the herbarium of the New York Botanical Garden; isotype in the United States National Herbarium. Flowers pinkish. Only collection seen.

A species distinctly characterized by the abundantly branching habit. In the floral characters it shows evident relationship with *P. torta* and *P. davidi*, especially in the 3 calyx-teeth and in the twisted galea. But this new species has shorter, simply curved instead of slender and sigmoid beak, and tridentate calyx-teeth. The inflorescence is also much shorter and with fewer flowers.

Series 64. Dissectae ser. nov.

Plants erect, medium-sized; stems branching at base or above; leaves mostly cauline, alternate, petiolate, ovate-oblong, pinnatisect, the segments oblong, remote, narrowed at base, pinnatifid and serrate; flowers long-pedicellate, the pedicels usually longer than the flowers, slender, the lower flowers axillary, scattered, the upper ones shorter-pedicellate and racemosely arranged; bracts foliaceous, petiolate, dissected; calyx cylindric-campanulate, membranaceous, reticulate or not, cleft anteriorly, 3-5-dentate, the posterior smaller, narrow, entire to subentire or dentate, the others broad, distinctly dentate, narrowed at base or not; corolla whitish, yellowish, or reddish (?), the tube slightly longer than the calyx, erect, galea strongly twisted, produced into a slender filiform beak, the beak curved, upraised, entire at apex; lower lip more or less ciliate on the margins, 3-lobed, the lobes rounded, the middle lobe much smaller, scarcely distad; stamens inserted near the middle of the tube, the filaments all hairy; styles included.

About 3 species in Sikang and southern Shensi (Map 36).

The species forming this series were originally included by Bonati in the Oxycarpae. They differ from the species of the latter notably in the very long pedicels, the axillary scattered lower flowers, and the short capsules. The flowers resemble those of certain Oxycarpae with twisted galea but evidently the two groups are distinct. In the characters mentioned above, the Dissectae are somewhat near the Longipedes. The information concerning the flower color is not complete; it seems that the corollas are either whitish or yellowish.

Key to the Species

A. Calyx not reticulate, the teeth 5, the mid-posterior entire, the others dentate. 230. *P. souliei*

AA. Calyx slightly reticulate distally, the teeth 3, the posterior entire to subentire, the others distinctly dentate.

- B. Stems single, few-branched above; leaves sparsely hairy beneath, the segments broader, about 4-5 mm. wide, serrate; calyx hairy externally, the teeth irregularly dentate. .... 231. *P. petitmenginii*
- BB. Stems many-branched below; leaves glabrous beneath, the segments narrower, 2-3 mm. wide, sharply serrate; calyx glabrous externally, the teeth 3-lobed and dentate. .... 232. *P. dissecta*

230. **Pedicularis souliei** Franchet Plate II, fig. 189.

Pedicularis souliei Franch., in Bull. Soc. Bot. France, 47: 23, 1900; Bonati, in Bull. Herb. Boiss. II, 7: 542, fig. 9-13, 1907; Limpricht, in Repert. Sp. Nov., 20: 246, 1924. The types were from Sikang: "Su-tchuen autour de Ta-tsien-lou (Soulié, n. 830); Tongolo, dans la mousse et dans les marais inondés (id., nos 220 et 385)." A duplicate of one of the syntypes, *Soulié* 385, is in the Bonati Herbarium; it will divide between the Academy of Natural Sciences of Philadelphia and the University of California at Los Angeles.

Swampy places in Sikang. Flowers reddish or whitish.

SIKANG: Tongolo, *Soulié* 385 (ANSP, UCLA); no precise locality, *Soulié* 2867 (ANSP, UCLA); La-tra, *Soulié* 2858 (NYBG).

A species characterized by the axillary long-pedicellate flowers, the lower scattered and very distant, while the upper are shorter-pedicellate and racemosely arranged. The calyx has 5 teeth, the lateral ones all dentate, and the corolla is strongly twisted. Its relationship is undoubtedly with *P. petitmenginii,* a similar species with but 3 calyx-teeth.

231. **Pedicularis petitmenginii** Bonati Plate II, fig. 190.

Pedicularis petitmenginii Bonati, in Bull. Herb. Boiss. II, 7: 542, fig. 1-8, 1907; in Bull. Soc. Bot. France, 54: 184, 1907; Limpricht, in Repert. Sp. Nov., 20: 246, 1924. The type was from Sikang: "Typus in herb. Barbey-Boissier. Soulié, no 122: Ta-Tsien-Lou." Isotypes from the Bonati Herbarium are in the herbarium of the Academy of Natural Sciences of Philadelphia and the University of California at Los Angeles. Bonati originally described the staminal filaments as glabrous and the margins of the lower corolla-lip as also glabrous. However in the available isotypes the filaments are found to be densely hairy and the lower lip very sparsely ciliate on the margins.

Pedicularis sparsiflora Bonati, in Kew Bull., 1908: 253, 1908; Limpricht, in Repert. Sp. Nov., 20: 246, 1924. The type was from: "Western China. Without locality, *Wilson,* 4257a." It has not been seen. Bonati in 1907 (in Bull. Soc. Bot. France, 54: 184, 1907) identified *Wilson* 4257 as *P. petitmenginii.* In 1908 he described *P. sparsiflora* from *Wilson* 4257a, apparently from the same collection. Neither of these numbers has been seen. Bonati indicated that *P. sparsiflora* is very near *P. petitmenginii* but differs in the villose filaments, ciliate lobes, etc. As the type specimens show that Bonati's original characterizations of *P. petitmenginii* with glabrous filaments and lower lip are incorrect, the ground on which he distinguished *P. sparsiflora* from *P. petitmenginii* does not exist. Unless the actual specimens can reveal notable differences between them, it is necessary to combine the two supposedly different species into one.

In Sikang. Flowers whitish or yellowish.

SIKANG: Tatsienlu, *Soulié* 122 (ANSP, UCLA), *Cunningham* 463 (RBGE), 531 (RBGE).

A species resembling closely *P. souliei* in the general habit, the long pedicels, and twisted galea. They differ from each other in the calyx characters. The calyx of *P. souliei* is glabrous, non-reticulate, and with 5 teeth, the mid-posterior small and entire and the others oblong, broad at base and few-dentate distally. In *P. petitmenginii* the calyx is hairy externally, slightly reticulate distally and with 3 teeth, the mid-posterior smaller and subentire to slightly dentate, the lateral ones very broad, ovate, constricted at base and irregularly dentate distally.

232. **Pedicularis dissecta** (Bonati) Pennell & Li, comb. nov. Plate II, fig. 191.

Pedicularis petitmenginii Bonati var. *dissecta* Bonati, in Bull. Soc. Bot. France, 55: 245, 1908; Limpricht, in Repert. Sp. Nov., 20: 246, 1924. The types were from " Shen-Si septentrional (*R. P. Giraldi*), 1898 et 1899, n^{os} 1230, 5528, 5533, 5567, 5568, 5569 *in* Herb. Mus. Florence." Duplicates of the syntype *Giraldi* 1230, from the Bonati Herbarium, are at the Academy of Natural Sciences of Philadelphia and the University of California at Los Angeles.

Pedicularis davidi Franch. var. *flaccida* Diels ex Bonati, in Bull. Soc. Bot. France, 55: 245, 1908 (in syn. sub. *P. petitmenginii* var. *dissecta*) *nomen nudum.*

Plant 2.5 dm. or more tall; stems many-branched below, rigid, slender, erect, puberulous to glabrescent, branching above; leaves cauline, alternate, long-petiolate, the petioles to 1.5 cm. long, slender, the blades ovate-oblong, to 3 cm. long and 1.5 cm. wide, glabrous, pinnatisect, the segments 7 or 8 on each side, remote, linear-oblong, to 2-3 mm. wide, pinnatifid and serrate; flowers very long-pedicellate and somewhat racemose; bracts leaf-like, finely dissected, petiolate; pedicels to 2.5 cm. long, slender, erect or not, puberulous; calyx cylindric-campanulate, about 4-5 mm. long, membranaceous, glabrous, hardly reticulate distally, cleft anteriorly, 3-dentate, the teeth unequal, the mid-posterior one small, oblong, acute, entire to subentire, the laterals large, narrowed proximally, broadened distally, 3-lobed, the lobes sharply dentate; corolla about 1.1 cm. long, the tube erect, hairy externally, longer than the calyx; galea strongly twisted, produced into a long filiform beak, the beak about 4 mm. long, strongly curved, the apex emarginate; lower lip ciliate on the margins, 3-lobed, the lobes rounded, the middle lobe much smaller, hardly distad; stamens inserted near the middle of the tube, the filaments all hairy, the anthers oblong; style included; capsules unknown.

In northern Shensi. Flowers whitish or yellowish (?). Flowering in August.

SHENSI: Tai-pei Shan, *Giraldi* 1230 (ANSP, UCLA).

A species related to *P. petitmenginii* but differing in the habit, the leaves, and the calyx. The stem is rather rigid but slender, and is many-branched near the base and above. The leaf-segments, as compared with those of *P. petitmenginii*, are narrower, more sharply cut, and glabrous instead of hairy beneath. The calyx is glabrous and with trilobed teeth.

SECTION XVIII. PHANERANTHA

Tall or medium-sized plants, usually pubescent; roots thickened; stems several, simple distally; leaves mostly radical, the few cauline ones alternate, smaller and shorter-petiolate, otherwise similar to the radical, these long-petiolate, narrow, oblong to lanceolate, deeply pinnatifid, their lobes pinnatifid to serrate; inflorescences of short to long racemes, the flowers compact to lax, the pedicels erect; bracts foliaceous; calyx cylindric to oblong, usually cleft anteriorly, rarely uncleft, 2-5-dentate, the teeth narrowed proximally, serrate to crenate distally; corolla purple to reddish, rarely white proximally, the tube about as long as the calyx; galea strongly bent, cristate or not, beaked, the beak long, curved, bifid or entire; lower lip broad, 3-lobed, the lobes rounded, subequal or the middle lobe smaller, hardly distad, the margins glabrous or ciliate; stamens inserted near the throat or at the middle of the tube; all staminal filaments hairy or rarely the posterior glabrous; stigmas slightly exserted.

The section comprises the series Macranthae and also the Robustae, a series of the eastern Himalayas. These species have strongly cleft calyx and relatively large corolla with rather short but much dilated corolla-tube. The range of the section extends from the eastern Himalayas to southwestern China.

Series 65. Macranthae

Macranthae Prain, in Ann. Bot. Gard. Calcutta, 3: 69, 1890.

Characters of the section.

About 4 or 5 species from the eastern Himalayas to northwestern Yunnan and Sikang (Map 37).

The series is characterized by the relatively short corolla-tube with strongly curved galea and beak. Its closest relationship is probably with the Robustae of India.

Key to the Chinese Species

A. Lower lip of corolla densely ciliate on the margins; beak distinctly bifid; calyx deeply cleft anteriorly, the teeth 3, rarely 5. .... 233. *P. elwesii*

AA. Lower lip of corolla glabrous on the margins; beak entire, not bifid; calyx cleft anteriorly to about the middle of the tube, the teeth 2-5.

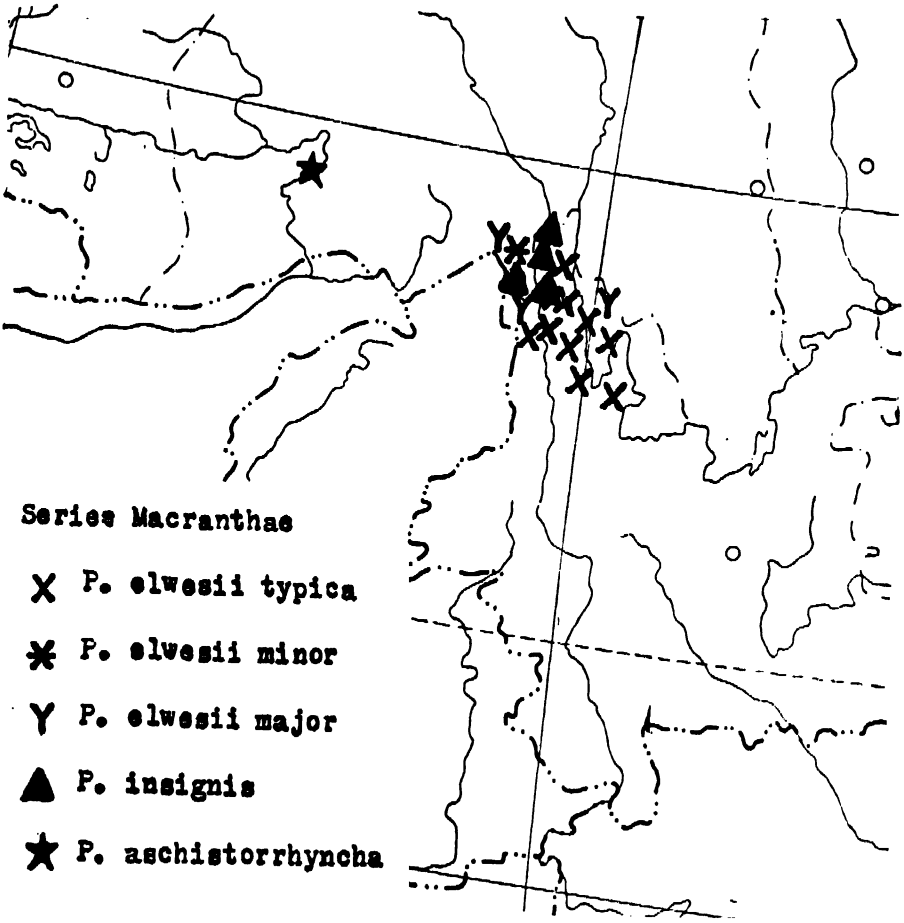
  B. Calyx teeth 5; corolla purple throughout; galea prominently cristate in front with a short tooth on each side of the lower margins; beak strongly bent; 2 or all staminal filaments hairy. .... 234. *P. insignis*

  BB. Calyx-teeth 2; corolla white with purple beak; galea not twisted in front, without teeth on the lower margins, the beak short, decurved. 235. *P. aschistorrhyncha*

233. **Pedicularis elwesii** J. D. Hooker

Key to the Varieties

A. **Plants to about 2 dm. or less tall, the stems more or less spreading at base; basal leaves to 18 cm. long and 2.5 cm. wide; racemes shorter, about 5-8 cm. long, more or less compactly flowered; calyx-teeth 3-5.**



Map 37.—Distribution of the series Macranthae.

B. Plant to 2 dm. tall, the stems slightly spreading at base; calyx-teeth 3. 233a. *P. e. typica*

BB. Plant hardly 1.5 dm. tall, the stems strongly spreading at base; calyx-teeth usually 5, rarely 3. .... 233b. *P. e. minor*

AA. Plant to more than 3 dm. tall, the stems erect; basal leaves to 25 cm. long and 4.2 cm. wide; racemes longer, to 15 cm. long, the lower flowers laxly and remotely arranged; calyx-teeth 3. .... 233c. *P. e. major*

233a. **Pedicularis elwesii typica** Plate 12, fig. 192.

Pedicularis elwesii Hook. f., Fl. Brit. Ind., 4: 312, 1884; Maxim., in Bull. Acad. St. Pétersb., 32: 532, fig. 8, 1888; in Mél. Biol., 12: 793, fig. 8, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 208, 1890; Bonati, in Notes Bot. Gard. Edinb., 8: 37, 1913; 15: 164, 1926; 17: 66, 1929; Limpricht, in Repert. Sp. Nov., 20: 256, 1924; 23: 338, 1927; Marquand, in Journ. Linn. Soc. Bot., 48: 212, 1929; Hand.-Maz., Symb. Sin., 7: 864, 1936. The types were from: "Sikkim Himalaya; Lachen Valley, alt. 12-14,000 ft. J. D. H[ooker], Elwes." In the Bonati Herbarium there is a sheet of *J. D. Hooker* 24 (ex Mus. Bot. Berol.) from Sikkim, alt. 14,000 ft., apparently a duplicate of one of the syntypes; this will pass to the University of California at Los Angeles.

Alpine meadows at altitudes of 3200 to 4300 meters from the eastern Himalayas to northwestern Yunnan. Flowers purple to purplish red. Flowering in July and August.

YUNNAN: Lao-tong, *Delavay* s.n. (ANSP, NTU, UCLA); Yen-tze-hay, *Delavay* s.n. (ANSP, NYBG, UCLA), 2381 (NTU, NYBG); Likiang, *Schneider* 1962 (USNH), 3424 (USNH), *Forrest* 27836 (ANSP); Bei-ma-shan, *Forrest* 14405 (UCLA); Londre pass, Mekong-Salween divide, *Forrest* 19699 (ANSP); eastern slopes of Likiang Snow Range, *Rock* 4919 (USNH), 5440 (USNH), 9829 (GH, USNH); Mount Shwemenkan between the Chungtien River and the Yangtze, northwest of the Likiang Snow Range, *Rock* 9735 (USNH); Mount Peimashan, Mekong-Yangtze divide between Atuntze and Pungtzera, *Rock* 10022 (ANSP, UC, USNH); mountains of Nakela, east of Yuragan, Mekong-Salween divide, *Rock* 23091 (UC, UP); Haba Shan, north of the Yangtze loop, third peak of Likiang Snow Range, Bardar, *Rock* 24767 (CM, MBG, NYBG, UC, UP, USNH), 25317 (NYBG, UC, UP); Sung-kwe pass between Likiang and Hoking, north of Likiang, *Rock* 25196 p.p. (UC); Atuntze, *C. W. Wang* 64778 (AA); Bei-mar-shan, Atuntze, *C. W. Wang* 69518 (AA); Chungtien, Haba, *Yü* 13555 (AA); Upper Kiukiang Valley (Clulung), Lungtsahmuru, *Yü* 19844 (AA); Chungtien Plateau, *Feng* 1615 (AA); no precise localities, *Yü* 8848 (AA), 12670 (AA), *Forrest* 28755 (ANSP), 30849 (ANSP).

An elegant plant with very large brilliantly purple to purplish-red flowers. The stems are many and slightly spreading at base. It can be readily distinguished from allied species by its large flowers, strongly cleft calyx, bifid beak, and by the margin of the lower corolla lip being densely ciliate.

233b. **Pedicularis elwesii minor** var. nov.

A typo speciei differt plantā minore ad 15 cm. altā, caulibus diffusis, superne adscendentibus; calycibus plerumque 5-dentatis.

Type, in alpine meadows at an altitude of about 3800 meters on the northern slopes of Mt. Kenichunpo north of Sikitung, Upper Salween River, Tsarung Region, in Sikang Province, collected in flower, May-June 1932, by J. F. Rock, No. 22167; holotype in the herbarium of the New York Botanical Garden; isotypes in the herbaria of the Chicago Natural History Museum, the University of California, the University of Pennsylvania, and the United States National Herbarium. Only collection seen.

This variety differs from the typical form of the species in being a lower plant with more spreading stems and with mostly 5-dentate calyces. In some cases, often on the same plant, the two antero-lateral calyx-teeth may be much smaller than the other two, or even absent.

233c. **Pedicularis elwesii major** var. nov.

A typo speciei differt plantā majore; caulibus erectis, ad 32 cm. altis; foliis infimis longioribus, ad 25 cm. longis, petiolis ad 12 cm. longis, laminis ad 13 cm. longis 4.3 cm. latis; racemis longis ad 15 cm. longis, multifloris, floribus inferioribus laxis.

Type, in alpine meadows at an altitude of about 3660 meters, Solo-la, Tsarung Region, Sikang Province, collected in flower, May-June, 1932, by J. F. Rock, No. 22251; holotype in the herbarium of the New York Botanical Garden; isotypes in the herbaria of the University of California, the University of Pennsylvania, and the United States National Herbarium.

Alpine meadows at altitudes of 3500 to 3700 meters in southern Sikang and northwestern Yunnan. Flowers red-purple. Flowering from June to August.

SIKANG: Tsarung region, Solo-la, *Rock* 22251 (NYBG, UC, UP, USNH), 22678 (UC, UP).

YUNNAN: Chungtien Plateau, *Forrest* 10805 (ANSP, UC); Upper Kiukiang Valley (Clulung), Chialamuto, *Yü* 19738 (AA).

This variety, as compared with the type, is a taller, more robust plant and with more erect stems. The basal leaves are very long and much larger. The racemes are not only much longer and with more flowers but also with the lower flowers more remotely arranged. Capsules are present on *Rock* 22678 and these are similar to those of the typical form of the species.

234. Pedicularis insignis Bonati Plate 12, fig. 193.

Pedicularis insignis Bonati, in Notes Bot. Gard. Edinb., 13: 109, 1921; Limpricht, in Repert. Sp. Nov., 20: 256, 1924; Hand.-Maz., Symb. Sin., 7: 865, 1936. The type, "'S.E. Tibet:—Doker-la; 14,000 ft. On screes. Flowers crimson. 1913.' F. Kingdon Ward, No. 1105," in the Edinburgh Herbarium has been seen. This locality is in northwestern Yunnan near the Sikang border.

Pedicularis quadrata Bonati, in Notes Bot. Gard. Edinb., 13: 115, 1921; Limpricht, in Repert Sp. Nov., 20: 245, 1924. The type, "'S. E. Tibet:—Precipices, alpine turf, etc., Ka-gwr-pw. Alt. 15,500 ft. July 1913.' F. Kingdon Ward. No. 812," in the Edinburgh Herbarium has been seen. A photograph is in the Academy of Natural Sciences of Philadelphia. Bonati described this at the same time that he described *P. insignis*, but he placed the two species in two different series. He said originally that *P. quadrata* has some affinities with the species of the series Robustae and Oxycarpae, in the latter group the nearest relative being *P. tibetica*. But he concluded that, "Its true position appears to be in the group of the Oliganthae of Prain" where he placed it. The description clearly shows that its relationship is not with the Oliganthae but is with the Macranthae, and it is especially close to *P. insignis*, described by him at the same time. An examination of the type, available at a later date, proves that the two species are identical.

Alpine meadows at altitudes of about 4200 to 4700 meters, in northwestern Yunnan and southern Sikang. Flowers crimson to reddish purple. Flowering in July and August.

SIKANG: Ka-gwr-pw, *Ward* 812 (RBGE).

YUNNAN: Doker-la, *Ward* 1105 (RBGE); Sila, Mekong-Salween divide, *Yü* 22284 (AA).

This species is strongly characterized by its tomentose leaves, strongly cristate galea, and slender, curved beak.

235. Pedicularis aschistorrhyncha Marquand & Shaw

Pedicularis aschistorrhyncha Marquand & Shaw ex Marquand, in Journ. Linn. Soc. Bot., 48: 210, 1929. The type, "S.E. Tibet: In marshy meadows. Tumbatse, 3400-3600 m., July 13, 1924, *F. Kingdon Ward* 5930," has not been seen.

The locality is in western Sikang near the Tsang-po River.

In alpine meadows at altitudes of 3400 to 3600 meters in western Sikang. Flowers white with purple galea. Flowering in July. Known from the original collection only. No specimen seen.

This species was described as related to *P. scullyana* Prain, *P. macrantha* Klotzsch and *P. insignis*, all of the Macranthae, the first two being found in India. The species, as described, has mostly basal long-petiolate and pinnatifid leaves and a few similar but smaller cauline ones. The inflorescences are short-racemose. The calyx has 2 foliaceous pinnatifid teeth. The corolla is white proximally and with purple galea and has a short tube and a short decurved beak. Two of the staminal filaments are hairy. The combined characters indicate that it is rather different from other species of the series and may not be properly placed here. In the absence of type material, however, it is tentatively retained in the series.

GREX III. POECILOPHYLLUM

Humiles vel elatae; caulibus gracilibus, flexuosis vel scandentibus, raro rectis; foliis alternis, oppositis, vel suboppositis; floribus plerumque longe pedicellatis, raro subsessilibus vel breviter petiolatis, axillaribus, sparsis, raro densis.

SECTIO XIX. BRACHYCHILA. Altissimae, subrectae vel scandentes; foliis plerumque oppositis, raro suboppositis vel alternis, pinnatifidis vel pinnatisectis; galeā edentatā, haud rostratā; labio inferiore valde brevi.

Series 66. Aloënses. Gracillimae; calyce haud fisso, 5-dentato; labio inferiore galeam breviore, lobo medio obovato, obtuso, lobis lateralibus ovatis vel acutis. (Species 236-239, figures 194-195.)

SECTIO XX. PTERIDIOIDES. Humiles vel altissimae, rectae vel scandentes; foliis radicalibus grandibus, longe pedicellatis, pinnatisectis, caulinis parvioribus; floribus subsessilibus vel breviter petiolatis, densis, terminalibus vel axillaribus.

Series 67. Pteridifoliae. Strictae; foliis caulinis valde parvibus, sessilibus, pinnatifidis; floribus terminalibus, densis; corollae tubo calycem 2-3-plo longiore; galeā apice acutā, haud rostratā. (Species 240, figure 196.)

Series 68. Phaceliaefoliae. Strictae; foliis caulinis parvibus, pinnatisectis; floribus terminalibus, densis; corollae tubo calycem aequante vel duplo longiore; galeā distincte rostratā; rostro filiformi, gracili, plus minusve curvato. (Species 241-242, figures 197-198.)

Series 69. Vagantes. Altissimae, debiles, scandentes; foliis radicalibus grandibus, caulinis valde parvibus, pinnatifidis; floribus densis, axillaribus; corollae tubo calycem duplo longiore; galeā distincte rostratā; rostro conico, plus minusve recto. (Species 243, figure 199.)

SECTIO. XXI. DOLICHOMISCHUS. Altissimae, raro subacaules, debiles, vagantes vel scandentes; foliis radicalibus et caulinis, caulinis alternis et

oppositis vel suboppositis, plerumque pinnatisectis; floribus longe pedicellatis, axillaribus, sparsis; calyce haud fisso raro subfisso, 5-dentato.

Series 70. Acaules. Subacaules; foliis pinnatisectis; floribus axillaribus; corollae tubo calycem duplo longiore; galeā glabrā, haud rostratā, apice obtusā vel acutā; labio inferiore galeam subaequante, lobis rotundatis. (Species 244, figure 200.)

Series 71. Corydaloides. Altissimae, ramosae; foliis pinnatifidis; floribus inferioribus axillaribus, sparsis, superioribus subracemosis; corollae tubo calycem duplo longiore; galeā sparse glandulari-pilosā, haud rostratā; labio inferiore galeam duplo longiore, lobis orbicularibus. (Species 245, figure 201.)

Series 72. Infirmae. Altissimae, carnosae; inflorescentiis plerumque subterminalibus; corollae tubo calycem ad duplo longiore; galeā rostratā; rostro recto, conico. (Species 246, figure 202.)

Series 73. Longipedes. Altissimae, graciles, debiles; floribus sparsis; corollae tubo calycem ad duplo longiore; galeā rostratā; rostro longo, gracili, plus minusve cylindrico, recto vel leviter curvato. (Species 247-257, figures 203-207.)

Series 74. Omiianae. Altissimae, graciles; foliis radicalibus grandibus, pinnatisectis, caulinis valde parvibus, pinnatisectis; corollae tubo longo, calycem 4-plo longiore; galeā longe rostratā; rostro cylindrico, recto, sublevato. (Species 254, figure 208.)

Series 75. Muscicolae. Altissimae, debiles; foliis radicalibus caulinis similaribus, pinnatisectis; corollae tubo longo, calycem 5-7-plo longiore; galeā rostratā; rostro conico vel filiformi, recto vel sigmoideo. (Species 255-258, figures 209-212.)

Series 76. Batangenses. Altissimae, graciles, scandentes; foliis caulinis, plerumque oppositis vel suboppositis, lineari-dissectis; corollae tubo longo, calycem 4-5-plo longiore; galeā margine bidentatā, apice rostratā; rostro gracili, recto. (Species 259, figure 213.)

SECTIO XXII. SCHIZOCALYX. Humiles vel elatiores, subrectae vel diffusae; foliis radicalibus vel caulinis, caulinis alternis, interdum oppositis vel suboppositis, pinnatisectis, raro pinnatifidis; floribus axillaribus, longe vel breviter pedicellatis; calyce fisso, 2-3- raro 5-dentatā; corollā rostratā.

Series 77. Franchetianae. Humiles; foliis pinnatisectis; floribus valde longipedicellatis; corollae tubo brevi, calycem vix superante, superne dilatato; galeā longe rostratā; rostro gracili, valde curvato. (Species 260-261, figure 214.)

Series 78. Wilsoniae. Humiles; foliis leviter lobatis vel profunde pinnatifidis; floribus longe pedicellatis; corollae tubo longo, cylindrico, calycem 2-2.5-plo longiore, superne dilatato; galeā longe rostratā; rostro cylindrico, recto vel sigmoideo. (Species 262-263, figure 215.)

Series 79. Longiflorae. Humiles vel elatiores; foliis profunde pinnatifidis vel pinnatisectis; floribus breviter raro longe pedicellatis; corollae tubo longo, calycem 3-4 interdum ad 15-plo longiore, superne haud dilatato; galeā longe rostratā; rostro gracili, curvato vel sigmoideo. (Species 264-282, figures 216-230.)

GROUP III. POECILOPHYLLUM

Diffuse or trailing, rarely erect, low or tall plants, the stems very slender, usually branching; leaves often both alternate and opposite or subopposite, deeply pinnatifid to usually pinnatisect, mostly long-petiolate; flowers alternate or opposite to subopposite, axillary and scattered, laxly arranged, rarely dense, usually long-pedicellate, rarely subsessile or short-pedicellate; corolla with a short or very long tube, the latter usually cylindric and not enlarged distally; galea with the apex entire or beaked.

The kinship of the different sections and series, as well as their degree of floral modification, are graphically shown in Diagram 3.

SECTION XIX. BRACHYCHILA

Erect, slightly pubescent or glabrous; stems and branches slender; leaves opposite or rarely opposite and ternate, sometimes subopposite or occasionally alternate, ovate, pinnatifid or pinnatisect, the segments oblong to ovate, pinnatifid, serrate; flowers axillary, scattered; calyx 5-dentate, the teeth deltoid; corolla yellow, sometimes white, greenish or rose, the tube erect, about twice as long as the calyx; galea more or less straight or slightly falcate, the apex entire; lower lip much shorter than the galea, the mid-anterior lobe obovate obtuse, the lateral lobes ovate acute; staminal filaments hairy or glabrous.

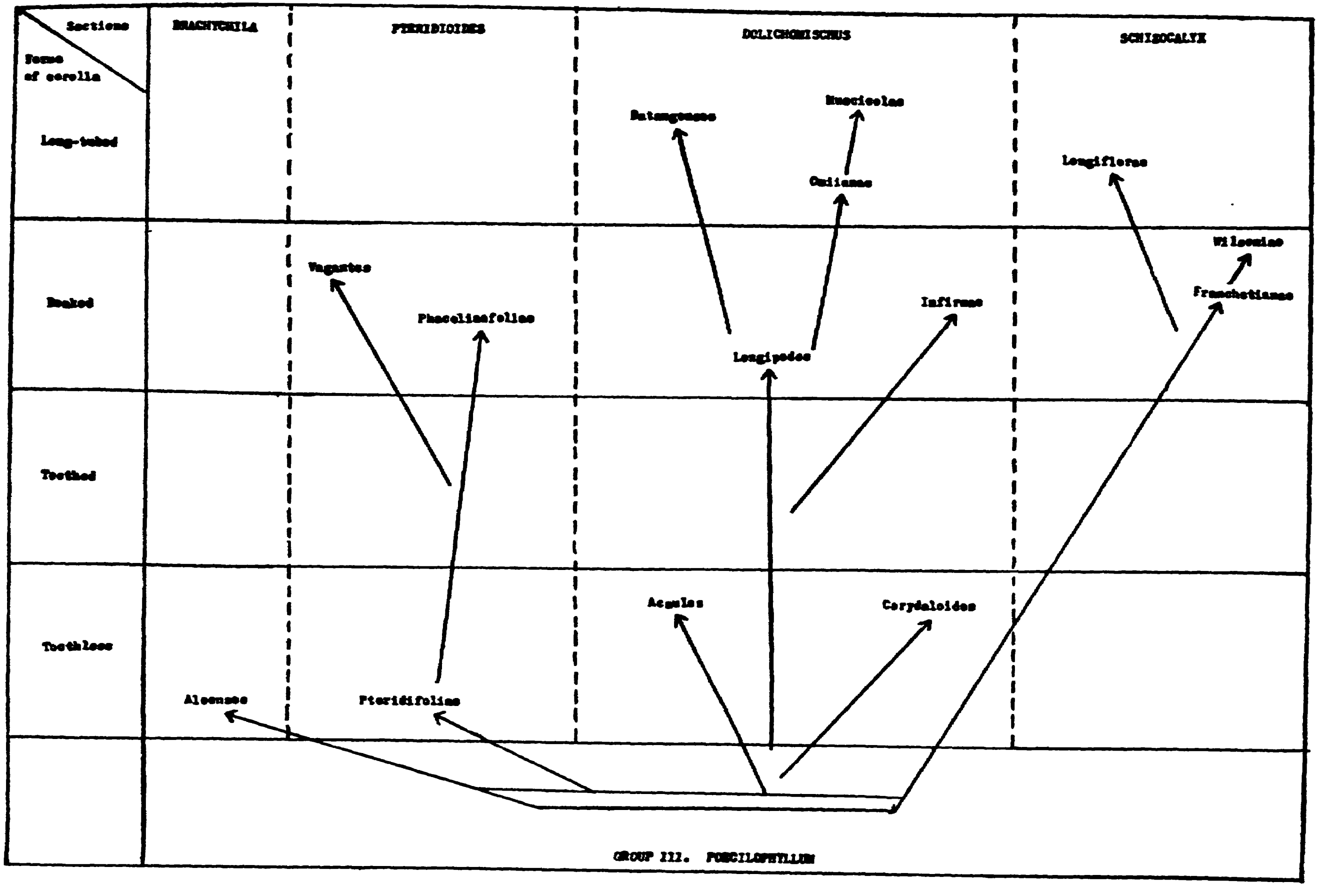
The series Aloenses on which this section is based is intermediate between the verticillate and alternate-leaved groups of the genus. It suggests little close relationship with other series. The range of the section is from the eastern Himalayas to northwestern Yunnan and Sikang.

Series 66. Aloenses ser. nov.

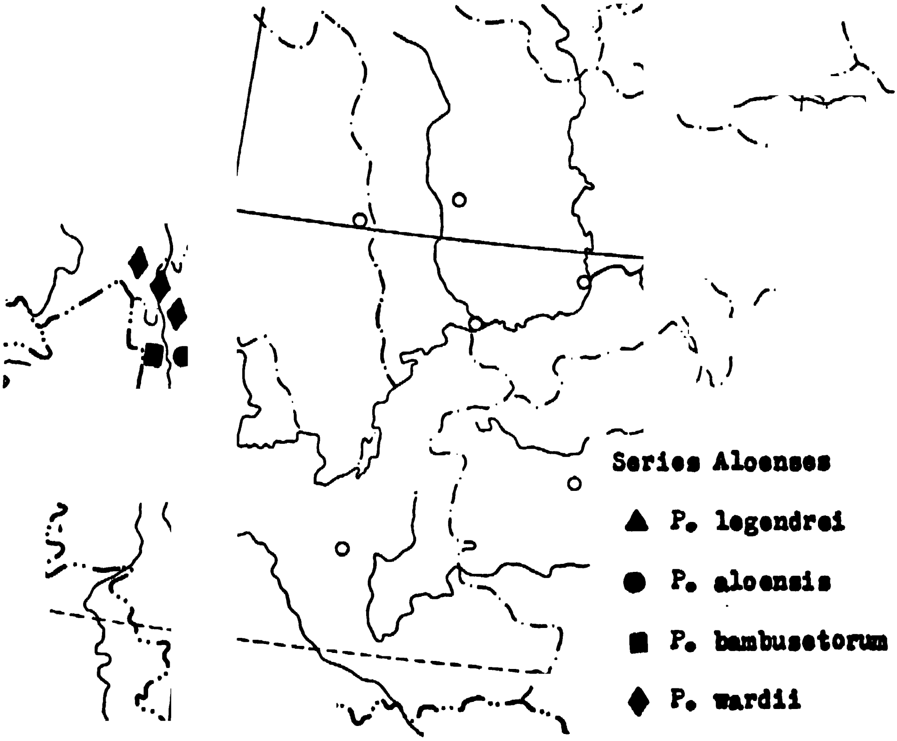
Fragiles Prain, in Ann. Bot. Gard. Calcutta, 3: 97, 1890, p.p.

Characters of the section.

Prain established the series Fragiles for two Indian species, *Pedicularis fragilis* Prain and *P. kingii* Prain. The first is found in Assam and the second in Sikkim as well as in the Chumbi Valley in extreme southern Tibet. Bonati subsequently added two species from China, *P. legendrei* and *P. wardii*. His key to the series (in Notes Bot. Gard. Edinb., 13: 134, 1921), thus included these four species. Handel-Mazzetti later added three species to the series, *P. aloensis*, *P. bambusetorum*, and *P. corydaloides*. The last-named species, being a distinctly alternate-leaved one with different floral characters, is now made into a separate series, Corydaloides. Of Prain's two original species, which he united into one series on account of their similarity in the corolla structure, *P. kingii* is very similar to the Chinese species in the long-petiolate opposite and subopposite leaves and forms with them a coherent group. *P. fragilis*, on the other hand, has ternate sessile leaves and is probably best treated as the single species of


Sections
Forms of corolla
Long-tubed
Beaked
Toothed
Toothless
BRACHYCHILA
PTERIDIOIDES
DOLICHOMISCHUS
SCHIZOCALYX
Batangenses
Muscicolae
Ouilianae
Longiflorae
Wilsonianae
Franchetianae
Vagantes
Phaceliaefoliae
Longipedes
Infirmae
Acaules
Corydaloides
Aloenses
Pteridifoliae
GROUP III. POECILOPHYLLUM

the Fragiles. Accordingly the Chinese species as well as *P. kingii* of India are here grouped into a series by themselves. These range from the eastern Himalaya to northwestern Yunnan, Sikang, and Szechuan (Map 38). The Chinese species can be differentiated by the following key.



Map 38.—Distribution of the series Aloenses.

Key to the Chinese Species

A. Corolla rose; lower lip nearly as long as the galea; 2 of the staminal filaments hairy. .... 236. *P. legendrei*

AA. Corolla yellow to greenish yellow; lower lip less than one half as long as the galea; filaments glabrous or slightly hairy.

  B. Corolla-tube about 4 mm. in diameter; filaments slightly hairy.

    C. Leaves to 5 cm. long, pinnatisect, with 4-5 segments on each side; calyx 3.5 cm. long; lower lip of the corolla 2.5 mm. long. .... 237. *P. aloensis*

    CC. Leaves to 7 cm. long, pinnatisect with about 5-7 pairs of segments; calyx 4 mm. long; lower lip of corolla 3-5 mm. long. ... 238. *P. aurata*

  BB. Corolla-tube about 2 mm. in diameter; filaments glabrous. ... 239. *P. wardii*

236. Pedicularis legendrei Bonati

Pedicularis legendrei Bonati, in Bull. Soc. Bot. France, 57: Sess. Extraord. lx, 1911; Limpricht, in Repert. Sp. Nov., 20: 212, 1924. Bonati's type, "Sze-tchuan, massif du Pao-shan, versant Nord-Est, près de Cha-tangtze, 2200 m., 'assez commune dans la forêt vierge.' *Dr. Legendre,* No 524, . . . ," has not been seen.

At an altitude of about 2200 meters in northeastern Szechuan. Flowers rose. Known from the original collection only. No specimen seen.

According to the description this species differs considerably from the others of the series in the lower lip being nearly as long as the galea and the corolla being rose-colored. It is also isolated in its distribution. It may be that the species does not properly belong to this series as originally indicated by Bonati and followed by Limpricht.

237. **Pedicularis aloensis** Handel-Mazzetti Plate 12, fig. 194.

Pedicularis aloensis Hand.-Maz., in Anz. Akad. Wiss. Wien Math.-Nat. Kl., 60: 99, 1923; Symb. Sin., 7: 851, 1936; Limpricht, in Repert. Sp. Nov., 20: 212, 1924. Handel-Mazzetti's type was from "Prov. Yünnan bor.-occ.: Inter vicos Bödö (Peti) et Hsiao-Dschungdien, in regionis frigide temperatae silva supra vicum Alo, s[olo] schisto argilloso, ca. 3800 *m.* legi 8. VIII, 1914 (Nr. 4582)." An isotype with rather young flowers, from the Bonati Herbarium, passes to the University of California at Los Angeles.

At an altitude of about 3800 meters in northwestern Yunnan. Flowers yellowish. Flowering in August.

YUNNAN: no data, *Yü* 8973 (AA); between Peti and Alo, Chungtien, *Handel-Mazzetti* 4582 (UCLA); Wei-si District, Kang-pu, *C. W. Wang* 64521 (AA).

238. **Pedicularis aurata** (Bonati) comb. nov. Plate 12, fig. 195.

Phtheirospermum auratum Bonati, in Notes Bot. Gard. Edinb., 13: 105, 1921. The type was from Yunnan: "'West China:—Open moist shady situations in pine forests on the mountains of the Chungtien Plateau, Yunnan. Lat. 27° 30′ N. Alt. 12,000 ft. Plant of 9-16 ins. Flowers deep golden-yellow. July, 1914.' G. Forrest. No. 12,873." Isotypes from the Bonati Herbarium pass to the Academy of Natural Sciences of Philadelphia, the University of California at Los Angeles, and the National Taiwan University.

Pedicularis bambusetorum Hand.-Maz., in Anz. Akad. Wiss. Wien Math.-Nat. Kl., 60: 99, 1923; Symb. Sin., 7: 851, pl. 15, fig. 3, 1936; Limpricht, in Repert. Sp. Nov., 20: 212, 1924. Handel-Mazzetti's type is from "Prov. Yünnan bor.-occ.: Prope fines Tibeto-Birmanicas inter flumina Lu-djiang (Salween) et Djiou-djiang (Irrawadi or. sup.), in jugi Tschiangschel, 27° 52′; lateris orientalis regione frigide temperata in bambusetis, s[olo] schistaceo, 3300-3400 m, legi 3. VII. 1916 (Nr. 9034)." A duplicate in the Edinburgh Herbarium has been seen. The original description is very brief, the author only contrasting it with *P. aloensis.* In 1936 a photograph of the plant was published. The type specimen available proves that the species is rather close to *P. wardii* and *P. aloensis,* and is identical with *P. aurata.*

At altitudes of about 3300 to 3600 meters in northwestern Yunnan and southern Sikang. Flowers yellow. Flowering in July.

SIKANG: Tsarung, Mt. Wuli-la, east of the Salween River and north of Alulaka, *Rock* 22367 (NYBG, UC); Chawchi, *Farrer* 1746 (RBGE).

YUNNAN: between Salween and Irrawadi, *Handel-Mazzetti* 9034 (RBGE); Chungtien Plateau, *Forrest* 12873 (ANSP, NTU, UCLA); A-tun-tze, Haaun-fu-ping, *C. W. Wang* 68750 (AA); Salween-Kui-Chiang divide, *Forrest* 20234 (ANSP, UCLA).

This species is a close relative of the other species of the series Aloenses. Bonati described this in the genus *Phtheirospermum* in a work where he also described *Pedicularis wardii.* Owing to lack of sufficient amount of authentic material, the Chinese species *P. aurata*, *P. wardii*, and *P. aloensis* cannot be sharply differentiated. It may be that only one or two species should be recognized.

239. **Pedicularis wardii** Bonati

Pedicularis wardii Bonati, in Notes Bot. Gard. Edinb., 13: 133, 1921; Limpricht, in Repert. Sp. Nov., 20: 212, 1924; Hand.-Maz., Symb. Sin., 7: 850, 1936. Bonati's type, "'S. E. Tibet:—Ka-gwr-pw Temple. Abies forest. Alt. 15,000 ft. July 1913.' F. Kingdon Ward. No. 881," has not been seen.

In spruce forests at an altitude of about 3000 meters in southern Sikang. Flowers yellowish. Flowering in July. Known from the original collection only. No specimen seen.

SECTION XX. PTERIDIOIDES

Stems long or short, erect or trailing; leaves radical and cauline, the radical very large, long-petiolate, fern-like, pinnatisect, the segments pinnatifid or serrate, the cauline smaller, alternate, subopposite or opposite; flowers subsessile to short-pedicellate, more or less in clusters terminating the stems or in axils of leaves; calyx cleft or not anteriorly, 5-dentate; corolla with the tube erect, broad, 2-3 times as long as the calyx; galea with the apex pointed or in a distinct beak; lower lip with the lobes subequal.

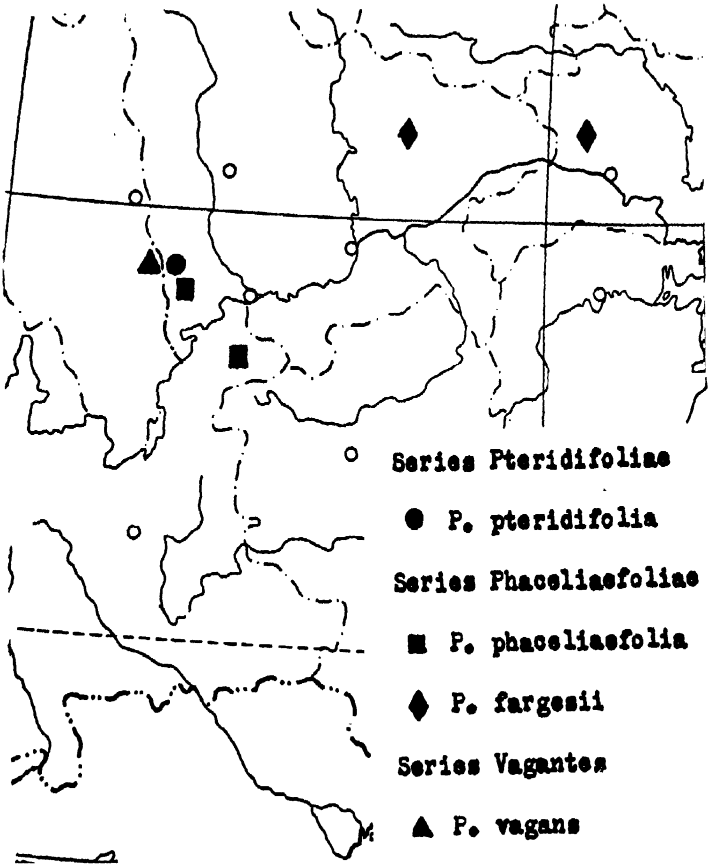
The species of this section form a natural group with very large radical, and relatively small cauline leaves, and with more or less clustered flowers. The section is mainly confined to Szechuan Province, with extensions to western Hupeh and northwestern Yunnan.

Series 67. Pteridifoliae ser. nov.

Perennials, root vertical with long filiform fibrous branches; stem erect, simple, glabrous, about as long as or shorter than the radical leaves, leafless or with only a few alternate, small, bract-like leaves; radical leaves large, long-petiolate, 20-28 cm. long, pinnatisect, the segments 7-9 on each side, distant, oblong, acute, pinnatifid, sessile to subsessile; flowers in terminal short spikes, subsessile; lower bracts foliaceous, upper bracts 3-lobed; calyx glabrous, not cleft anteriorly, 5-dentate, the teeth equal, entire, filiform, acute; corolla yellow; tube erect, glabrous, 2-3 times as long as the calyx; galea erect, slightly hairy on the margins, rounded in front, the apex pointed, not beaked, pointing downward; lower lip short, shallowly 3-lobed, the lobes subequal, the margins ciliate; stamens inserted at the base of the corolla-tube, 2 of the filaments slightly villose distally.

One species on Mount Omei, Szechuan Province (Map 39).

When Bonati first described *Pedicularis pteridifolia* he did not indicate to which series it belongs. In his keys (in Bull. Soc. Bot. France, 57, Mém. 18: 25, 1910; in Notes Bot. Gard. Edinb., 13: 133, 1921) he included it in the series Tristes. The floral character of *P. pteridifolia* does resemble *P. tristis* L. and indicates a relationship with that species. However, the vegetative characters, both in roots and leaves, of *P. pteridifolia* are so very



Map 39.—Distribution of the series Pteridifoliae, Phaceliaefoliae, and Vagantes.

different from all species of the series Tristes that the inclusion of this species with the others is scarcely warranted. In the leaf characters it is undoubtedly related to *P. vagans*.

240. **Pedicularis pteridifolia** Bonati Plate 12, fig. 196.

Pedicularis pteridifolia Bonati, in Kew Bull., 1908: 252, 1908; Limpricht, in Repert. Sp. Nov., 20: 228, 1924. The types were from: "Western China. Mount Omei, *Wilson*, 5080, 4550." They have not been seen.

At altitudes of 800 to 1600 meters, Mount Omei, Szechuan Province. Flowers yellow. Flowering in September and October.

SZECHUAN: Mount Omei, *Y. S. Liu* 1710 (AA).

The specimen referred to above, though fragmentary, agrees closely with the original description. This species is strongly characterized by having large basal leaves and an erect, almost leafless stem. The large, fern-like, radical leaves resemble those of *P. vagans*, but there are only 7-9 pairs of pinnae. The species further differs from *P. vagans* in the erect, shorter stem that bears either no leaves or else a few small bract-like ones, in the terminal short spikes of flowers, in the calyx not being cleft anteriorly, and in the corolla not being beaked. The corolla resembles that of *P. tristis* in general shape except that the margins of the galea are only slightly hairy; but in vegetative characters, both as to roots and leaves, *P. pteridifolia* and *P. tristis* are quite different.

Series 68. Phaceliaefoliae

Phaceliaefoliae Bonati, in Bull. Soc. Bot. France, 57, Mém. 18: 14, 1910.

Plants medium-sized, glabrous; roots fibrous, many, somewhat thickened; stems single or several together, simple or a few short-branched above, erect or suberect, few-leaved; leaves cauline and radical, the radicals large and very long-petiolate, the cauline petiolate, alternate, subopposite or rarely opposite, ovate-oblong, pinnatisect, the lobes broad, ovate, serrate, distant; inflorescences more or less compact; bracts foliaceous; flowers short-pedicellate; calyx membranaceous, slightly hairy when young, 5-nerved, slightly cleft anteriorly, 5-dentate, the teeth serrate, equal to unequal; corolla white or pink, the tube erect, as long as, to twice as long as, the calyx, the galea erect, ending in a distinct slender beak, the lower lip about as long as the galea, 3-lobed; staminal filaments densely hairy distally; styles scarcely exserted.

Two species in northwestern Yunnan, Szechuan and western Hupeh (Map 39).

The characteristic large and long-petiolate radical leaves are sometimes not collected in the specimens. This series was first formed by Bonati, and associated with the Axillares. But Limpricht assigned *P. phaceliaefolia* to the series Racemosae, and *P. fargesii* to the Furfuraceae, although they suggest these two series only in some superficial points. The two species have not only similar vegetative characters, but the structures of their calyces, corollas, stamens, etc., all indicate that they belong to the same series.

Key to the Species

A. Leaves coriaceous; calyx ovoid, the teeth subequal; corolla white, the tube scarcely longer than the calyx; beak curved downward, parallel to the lower part of the galea. .... 241. *P. phaceliaefolia*

AA. Leaves membranaceous; calyx cylindric, the teeth unequal; corolla pink, the tube slender, twice as long as the calyx; beak more or less straight, curved only distally, pointing forward, perpendicular to the lower part of the galea. 242. *P. fargesii*

241. Pedicularis phaceliaefolia Franchet Plate 12, fig. 197.

Pedicularis phaceliaefolia Franch., in Bull. Soc. Bot. France, 47: 27, 1900; Diels, in Bot. Jahrb., 29: 572, 1900; Bonati, in Bull. Herb. Boiss. II, 7: 544, 1907; in Bull. Soc.

Bot. France, 54: 186, 1907; Limpricht, in Repert. Sp. Nov., 20: 239, 1924; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 215, 1924. The types were from northwestern Yunnan: "Yunnan, dans les lieux frais des forêts des montagnes, à Tchen-fong-chan (Delavay, nos 2124, 4905)." They have not been seen.

Mountain slopes at altitudes of 1600 to 1850 meters in northwestern Yunnan and western Szechuan. Flowers white. Flowering in August.

SZECHUAN: Mount Omei, *Fang* 2644 (ANSP, GH, USNH), *Chiao & Fan* 472 (AA).

242. Pedicularis fargesii Franchet Plate 12, fig. 198.

Pedicularis fargesii Franch., in Bull. Soc. Bot. France, 47: 26, 1900; Diels, in Bot. Jahrb., 29: 572, 1900; Bonati, in Bull. Soc. Bot. France, 54: 185, 1907; Limpricht, in Repert. Sp. Nov., 20: 241, 1924. The type was from eastern Szechuan: "Su-tchuen, sur les rochers calcaires à Héou-pin, près de Tchen-keou-tin, alt. 1400 m. (Farges, n. 1201)." Duplicates from the Bonati Herbarium are at the Academy of Natural Sciences of Philadelphia and the University of California at Los Angeles.

Among limestone rocks at an altitude of about 1400 meters in eastern Szechuan and western Hupeh. Flowers white. Flowering in July.

HUPEH: western Hupeh, *Wilson* 2393 (NYBG).

SZECHUAN: Tchen-keou-tin, *Farges* 1201 (ANSP, UCLA).

Pedicularis fargesii as compared with *P. phaceliaefolia* has thinner leaves. They have the same membranaceous calyx which is slightly cleft anteriorly, 5-dentate, 5-nerved, scarcely reticulate above, and ciliate on the margins between the teeth. However in *P. fargesii* the calyx is shorter and ovoid and the teeth are broader and shorter with broader bases and are more or less equal. The calyx of *P. phaceliaefolia* is cylindric and the teeth are relatively longer, narrower at base and very unequal. *Pedicularis fargesii* differs further in the corolla-tube being twice as long as the calyx and with a beak that extends forward at right angles to the lower part of the galea, while in *P. phaceliaefolia* the corolla-tube is scarcely longer than the calyx and the beak curves downward and parallel to the lower part of the galea.

Series 69. Vagantes

Vagantes Prain, in Ann. Bot. Gard. Calcutta, 3: 81, 1890.

Tall plants with many fibrous, long, slightly thickened roots grown from a more or less horizontal rhizome; stem long, slender, prostrate, trailing to scandent; leaves radical and cauline, the radical very large, fern-like, membranaceous, sparsely setulose, long-petiolate, oblong-lanceolate, pinnatisect, the segments 11-12 on each side, pinnatifid, the cauline small, alternate to sub-opposite, distant, petiolate, ovate-oblong, pinnatifid, the lobes 5-7 on each side; flowers in dense clusters, axillary, short-pedicelled; bracts foliaceous; calyx tubular, glabrous, cleft anteriorly, 9-10-nerved, not reticulate, 5-dentate, the teeth unequal, dentate to subentire; corolla pink, the tube erect, longer than the calyx, the galea erect, slightly bending distally, produced into a distinct conical beak; the lower lip patent, longer than the galea and beak, the lobes subequal, rounded; staminal filaments all glabrous.

One species on Mount Omei, Szechuan Province (Map 39).

A very distinct species with large fern-like radical leaves and long slender stems bearing alternate to subopposite, small cauline leaves and clusters of flowers. The corolla is distinctly beaked. To a certain extent this species is probably related with the series Phaceliaefoliae and Pteridifoliae.

243. **Pedicularis vagans** Hemsley Plate 12, fig. 199.

Pedicularis vagans Hemsl. ex Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 218, 1890; in Hook. f., Icon. Plant., 20: pl. 1978, 1891; Diels, in Bot. Jahrb., 29: 572, 1900; Limpricht, in Repert. Sp. Nov., Beih. 12: 484, 1922; in Repert. Sp. Nov., 20: 232, 1924. The type was from: "Szechuan: Mount Omei, 4000 to 5000 feet (Faber!). Herb. Kew." A duplicate (ex Mus. Bot. Berol.), from the Bonati Herbarium, passes to the University of California at Los Angeles. It bears the original label with the number 183.

In thickets at altitudes of 950 to 1900 meters, Mount Omei, Szechuan Province. Flowers pink. Flowering in July.

SZECHUAN: Mount Omei, *Faber* 183 (UCLA), *Wilson* 5081 (ANSP), *Fang* 2623 (ANSP, GH, USNH), *F. T. Wang* 23332 (AA), *Peng* 83 (AA), *Chiao & Fan* 543 (AA).

A very striking plant with large long-petiolate fern-like basal leaves and long, slender more or less prostrate stem bearing small, alternate to subopposite leaves and more or less clustered flowers on short lateral branches. The basal leaves are sometimes not collected in the herbarium specimen. The flower is characterized by its long-tubular calyx, conical beak and the rather broad and long lower corolla-lip which is longer than the beak. The calyx is deeply cleft anteriorly, a character not noted by Hemsley when he described the species. Sometimes very short branches are present, bearing compact clusters of flowers, or the stem may be almost completely suppressed, resulting in the clusters of flowers being found near the base of the radical leaves. It may be that these basal flowers are cleistogamous.

SECTION XXI. DOLICHOMISCHUS

Stems usually long, rarely short, slender, spreading or diffused; leaves radical and cauline, these similar to each other, the cauline many, alternate and opposite or subopposite, petiolate, pinnatisect, rarely pinnatifid; flowers axillary, long- and slender-pedicellate, scattered; calyx not cleft or rarely slightly so anteriorly, 5-dentate; corolla with either short or very long, slender tube; galea beaked or beakless, the beak when present long, slender, straight or bending.

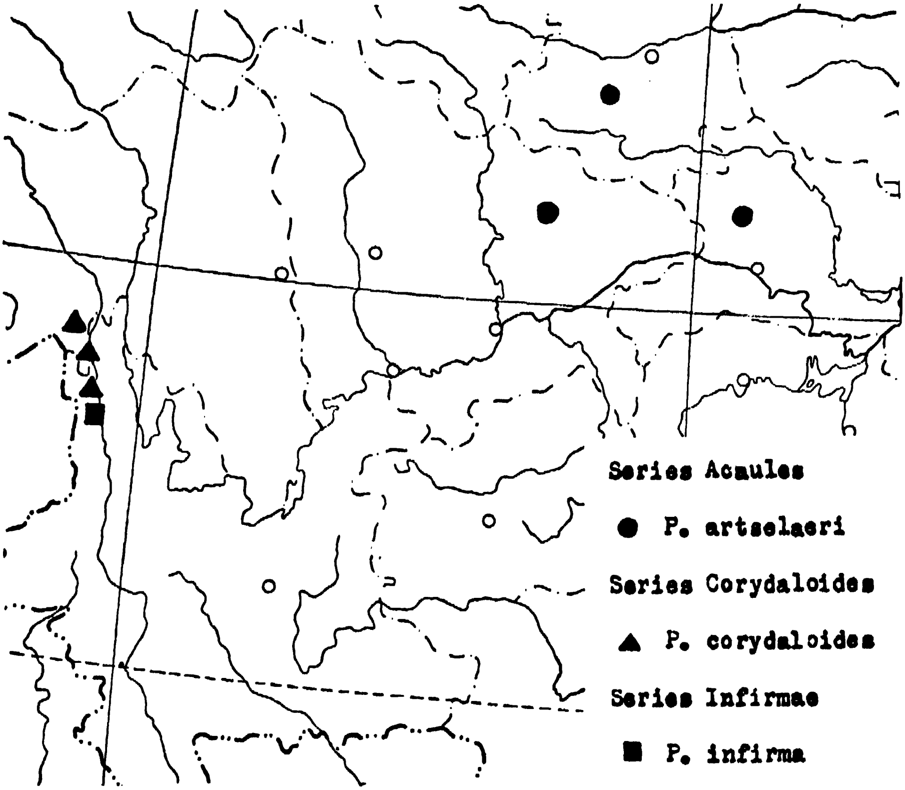
This section is characterized by the usually long, slender, spreading stems with alternate to subopposite and opposite leaves. It is related to and resembles the section Schizocalyx but may be distinguished therefrom by the usually longer and more slender stems, the more dissected leaves, and the usually uncleft calyx with 5 calyx-teeth. The range of the section is mainly in western China, with a few species also extending to northern China and Europe.

Series 70. Acaules

Acaules Prain, in Ann. Bot. Gard. Calcutta, 3: 91, 1890.

Low plants, acaulescent to subacaulescent; leaves alternate, long-petiolate, oblong-lanceolate, pinnatisect, the segments ovate, serrate-dentate; flowers all axillary, long-pedicellate; calyx cylindric, not cleft anteriorly, 5-dentate, the teeth lanceolate, serrate; corolla white or violet, erect, the tube twice as long as the calyx, the galea about equaling the lower lip in length, without teeth and beak, the apex acute or obtuse, the lower lip 3-lobed, the lobes rounded, subequal; capsules ovoid, completely enclosed by the calyx.

Two species, one in Europe and one in northern China (Map 40).



Map 40.—Distribution of the series Acaules, Corydaloides, and Infirmae.

Prain originally assigned three species to this series, *P. acaulis* Wulf. of Europe, *P. artselaeri* of northern China, and *P. regeliana* Prain of Sikkim, India. The European and Chinese species are closely related and undoubtedly should be included in the same series. The Indian species, however, differs considerably from the other two in its anteriorly cleft calyx, its rostrate and cristate galea, and its lanceolate fruit. It should thus be removed from the series. According to Prain's own classification the series Acaules belongs to " Erostres," and thus a rostrate species like *P. regeliana* is anomalous in this group even in his own system.

244. **Pedicularis artselaeri** Maximowicz Plate 12, fig. 200.

Pedicularis artselaeri Maxim., in Bull. Acad. St. Pétersb., 24: 84, 1878; 32: 616, fig. 166, 1888; in Mél. Biol., 10: 127, 1878; 12: 914, fig. 166, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 205, 1890; Diels, in Bot. Jahrb., 29: 572, 1900; 36. Beib. 82: 97, 1905; Bonati, in Bull. Soc. Bot. France, 54: 187, 1907; Limpricht, in Repert. Sp. Nov., 20: 198, 1924; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 209, 1934. Maximowicz's type was from "*Mongolia* orientali australi: Siwan-tze non procul ab oppido Kalgan (rev. Pat. Artselaer sp. l. legit 1876)." Kalgan is now known as Wan-chuan (or Chang-kia-kou), the capital of Chahar Province. The type has not been seen. Description and illustration distinctive.

In moist places at altitudes of about 1100 to 1500 meters in southern Chahar, southern Shensi, eastern Szechuan, and western Hupeh. Flowers purple. Flowering in May.

CHAHAR: Hsaio Wutaishan, *Kung* 50 (GH, NYBG).

SHENSIS Inkiapo, *Giraldi* 5540 (ANSP, UCLA).

HUPEH: no precise locality, *Henry* 5326 (GH, NYBG, USNH); western Hupeh, *Wilson* 1844 (NYBG).

SZECHUAN: Tchen-keou-tin, *Farges* s.n. (ANSP, UCLA).

A distinct species characterized by its subacaulescent habit, the stem hardly 3 or 4 cm. tall with long-petiolate, remotely pinnatisect leaves and axillary, long-pedicellate flowers. The flowers are rather large, the corolla measuring 3-4 cm. long. The capsules were described by Maximowicz in 1888 and are also represented in the specimens cited by *Wilson* 1844. They are broadly ovoid, slightly compressed, about 1 cm. long and 8 mm. wide, obliquely apiculate and completely included in the calyx. The fruit characters suggest relationship with *P. axillaris* and its relatives, and this relationship is further supported by other characters. From its European relative, *P. acaulis* Wulf., it is distinguished by leaf-segments being remote, pedicels longer, anther-cells pointed, galea acute instead of obtuse, and corolla purple instead of white.

Series 71. Corydaloides ser. nov.

Low plants, the stems very slender, erect, slightly hairy, sparsely long-branched above, with alternate remote scales at base, the branches more or less procumbent and ascending; leaves alternate, cauline, long-petiolate, elliptic, pinnatifid, the lobes on each side broadly oblong, shallowly pinnatifid; flowers axillary, the upper racemose; bracts foliaceous; calyx very sparsely pilose, 5-dentate, the posterior tooth smaller, triangular-lanceolate, entire, the others obovate, narrowed below, distinctly serrate above; corolla yellow, the tube cylindric, a little less than twice the length of the calyx, slightly enlarged and curved distally, the galea erect, sparsely glandular-pilose distally, rounded in front and minutely apiculate at apex; the lower lip subequal, the middle one slightly distad; stamens inserted near the middle of the tube, the anterior filaments pilose; styles included.

One species in northwestern Yunnan and southern Sikang, close to the Burmese border (Map 40).

The series is characterized by the slender branching habit, alternate pinnatifid leaves, the more or less densely arranged racemes, and the edentate galea. It suggests some relationship with the series Aloenses and Acaules but is evidently not very closely related.

245. **Pedicularis corydaloides** Handel-Mazzetti Plate 12, fig. 201.

Pedicularis corydaloides Hand.-Maz., Symb. Sin., 7: 851, pl. 15, fig. 4, 1936. Handel-Mazzetti's type was from "NW-Y[unnan]: Bambusreiche Gebüsche der ktp. St. [Kalttemperierte (subalpine) Stufe] des birm. Mons. [Nordost-birmanisch—west-yünnanesisches Monsungebiet] an der Westseite des Passes Pangblanglong zwischen Salwin und Irrawadi, 27° 58′, Glimmerschiefer, 3500-3800 m, 10. VII. 1916 (9515)." An isotype is in the Bonati Herbarium.

Alpine meadows at altitudes of 3200 to 3800 meters in northwestern Yunnan and southern Sikang. Flowers yellow. Flowering in July and August.

SIKANG: Djer-mai, Tsa-wa-rung, *C. W. Wang* 65750 (AA); Gue-sai-gue, Tsa-wa-rung, *C. W. Wang* 65816 (AA).

YUNNAN: Pangblanglong, between Salween and Irrawadi, *Handel-Mazzetti* 9515 (UCLA).

Handel-Mazzetti originally assigned this species to the series Fragiles Prain, although he noticed its anomality. From the species of the Fragiles, which in a more restricted sense here form the series Aloenses, it differs notably in the strictly alternate pinnatifid leaves, the densely racemose inflorescences and the relatively longer and larger lower lip of the corolla. The two groups are alike in appearance.

Wang 65750 is a fruiting specimen. The capsule is short-ovoid, very compressed, about 5 mm. long and 4 mm. wide, very obliquely acute, and completely included in the calyx. The pedicels become long and slender, to 1.2 cm. in length.

Series 72. Infirmae ser. nov.

Low perennial; roots fascicled, thickened; stems many, soft, fleshy, erect or flexuose, procumbent; leaves membranaceous, glabrous, radical or cauline, the radicals few, long-petiolate, ovate-oblong, pinnatisect, the segments about 6 or 7 on each side, ovate to oblong, deeply pinnatifid to nearly pinnatisect, the lobes serrate, the cauline leaves similar to the radical but smaller, alternate or sometimes subopposite; inflorescences terminating the stems, the lower flowers axillary and distant; bracts similar to the leaves; pedicels erect, slender; calyx ovoid-cylindric, sparsely hairy, slightly reticulate distally, slightly cleft anteriorly, 5-dentate, the teeth unequal, the posterior smaller, linear and serrate, the others large, narrowed proximally, broadened distally and irregularly incised-dentate; corolla purple, the tube erect, longer than the calyx, slightly pubescent externally; the galea falcate, produced into a straight conical beak, the lower lip ciliate on the margins, the lobes rounded, subequal; stamens inserted at the middle of the tube, the filaments all hairy; stigmas slightly exserted.

One species in northwestern Yunnan (Map 40).

The probable relationship of this series is with the Flexuosae, a series primarily of India. It has the same types of leaves and flowers but in the Flexuosae the leaves are supposed to be strictly opposite while in this new series, though some of the lower leaves may be subopposite, most of them are alternate.

246. **Pedicularis infirma** sp. nov. Plate 13, fig. 202.

Planta perennis ad 11 cm. longa; radicibus fasciculatis, crassis; caulibus multis, pubescentibus, valde infirmis, erectis vel flexuosis; foliis caulinis et parce radicalibus, radicalibus ad 13 cm. longis, longe petiolatis, petiolis ad 7 cm. longis, glabratis, tenuibus, laminis membranaceis, utrinque glabris, ovato-oblongis, acutis, circiter ad 5.5 cm. longis et 2.5 cm. latis, pinnatisectis, segmentis utrinsecus 6 vel 7, ovatis vel oblongis, acutis, inferioribus majoribus, ad 12 mm. longis et 9 mm. latis, profunde pinnatifidis vel subpinnatisectis, lobis utrinque 3 vel 4, ovatis, serratis, foliis caulinis alternis vel inferioribus suboppositis, radicalibus similibus at minoribus et breviter petiolatis; inflorescentiis terminalibus racemosis ad 8-9 cm. longis, floribus inferioribus axillaribus distantibus; bracteis foliaceis, petiolatis, pinnatisectis, inferioribus flores superantibus, superioribus eos subaequantibus; pedicellis ad 1.3 cm. longis, erectis, pubescentibus; calyce ovoideo-cylindrico, circiter 1-1.2 cm. longo externe villoso, superne parce reticulato, antice leviter fisso, prominente 5-dentato, dentibus inaequalibus, dente posteriore minore lineari, acuminato, serrato, basi haud constricto, dentibus lateralibus basi constrictis, superne profunde irregulariter inciso-dentatis, posterioribus paulo minoribus; corollā purpureā, circter 2 cm. longā: tubo erecto, calycem superante externe parce pubescente, superne dilatato; galeā falcatā, in rostrum conicum gradatim productā; rostro circiter 3 mm. longo, apice integro emarginato; labio inferiore superius superante, margine parce ciliatis, 3-lobatis, lobis rotundatis, subaequalibus, lobo medio vix porrecto; staminibus medium tubi insertis, filamentis omnibus villosis; stylo subexserto; capsulis ignotis.

Type, mountain slopes on open and sandy places at an altitude of 3000 meters, Taron-Taru Divide, Mt. Tarulaka, northwestern Yunnan, collected in flower, Sept. 3, 1938, by T. T. Yü, No. 20060; holotype in the herbarium of the Arnold Arboretum. Flowers light purple. Only collection seen.

This species is characterized by its relatively short, fleshy and soft, often somewhat flexuose stems with alternate to subopposite pinnatisect leaves. The calyx is shallowly cleft anteriorly and with 5 prominent teeth. The corolla has a short conical beak. The species resembles somewhat *P. flexu-*

osa Hook. f. of India, but the latter has strictly opposite leaves and a somewhat longer and more slender beak.

Series 73. Longipedes

Longipedes Prain, in Ann. Bot. Gard. Calcutta, 3: 74, 1890.

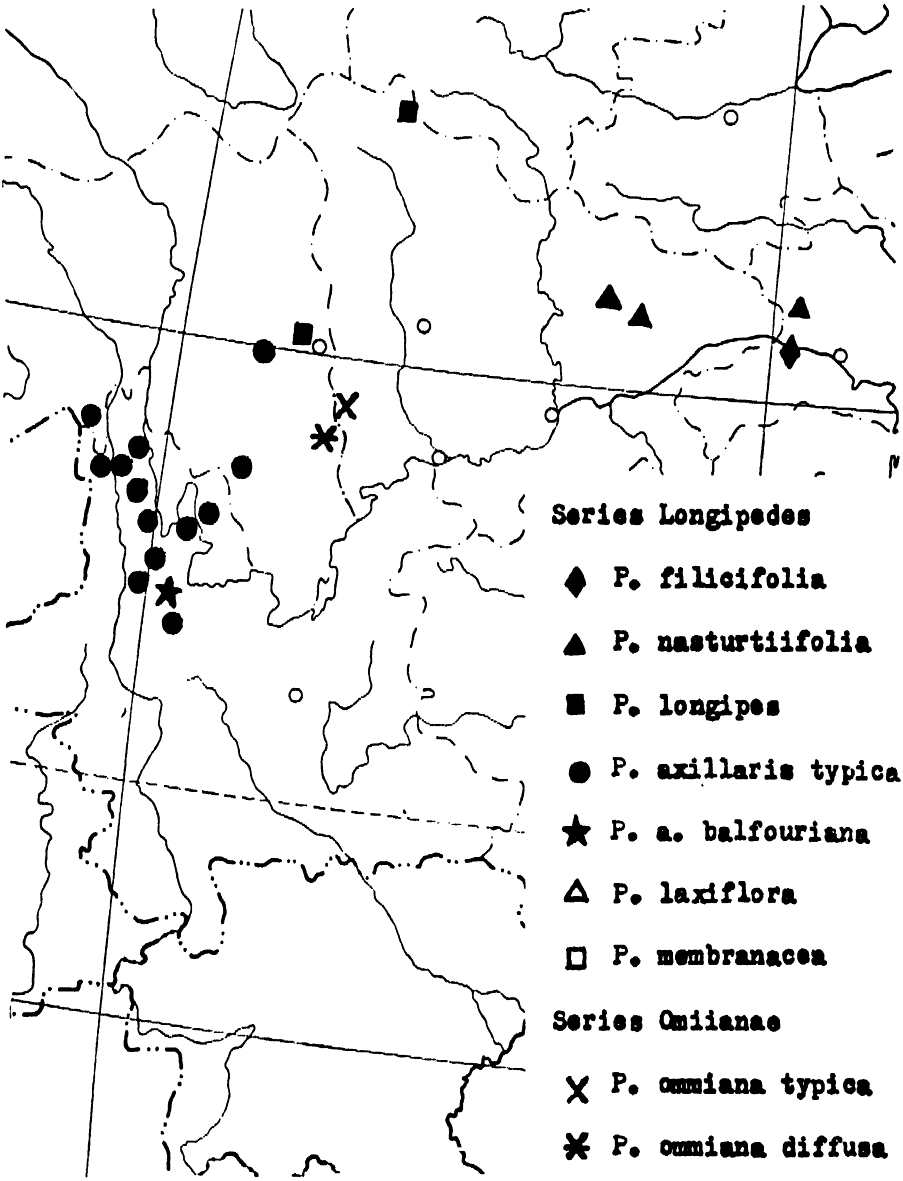
Low plants; stems many, very slender, erect or procumbent, usually puberulous; leaves opposite, subopposite to alternate, oblong to oblong-lanceolate, pinnatisect, the segments opposite to alternate, pinnatifid; flowers axillary, scattered, usually long-pedicellate; calyx campanulate, not cleft anteriorly or only very slightly so, 5-dentate, the teeth equal to unequal, ovate to lanceolate, serrate to subentire; corolla rose or purple, the tube erect, 1½-2 times as long as the calyx; galea produced into a long slender beak, the beak more or less straight or slightly bending; lower lip 3-lobed, usually slightly ciliate on the margins, the middle lobe rounded to acute, slightly distad; filaments inserted at the middle of the tube, glabrous, rarely the anterior or all slightly hairy.

About 7 species in Sikang, Szechuan, western Hupeh, and Yunnan (Map 41).

Prain originally grouped two species, *P. longipes* and *P. axillaris*, in this series. *P. filicifolia* was made by him into a separate series. These two series were combined into one in Bonati's first key (in Bull. Soc. Bot. France, 57, Mém. 18: 16, 1910) with the addition of *P. batangensis*, *P. nasturtiifolia*, *P. omiana*, *P. laxiflora*, etc. In 1921 he added three more species, *P. lacerata*, *P. tribuloides*, and *P. lucifuga*, to his revised key (in Notes Bot. Gard. Edinb., 13: 113-114, 1921). This was more or less followed by Limpricht in his enumeration (in Repert. Sp. Nov., 20: 257, 1924). *P. batangensis*, being a very distinct species, is here made into a separate series of its own. Three very long-tubular species, *P. omiiana*, *P. lucifuga*, and *P. tribuloides*, are also eliminated. *P. lophocentra*, originally described as an anomalous species of this series, is found to be a variety of *P. mussoti*. The remaining species constitute this series and they can be differentiated by the following key.

Key to the Species

- A. Leaves almost wholly opposite, rarely subopposite or only those near the top of the branches alternate.
  - B. Leaves pinnatisect, the segments 3-5 on each side.
    - C. Calyx with unequal teeth, the posterior smallest, linear and obscurely dentate, the others distinctly dentate; middle lobe of the lower corolla-lip rounded. .... 247. *P. filicifolia*
    - CC. Calyx with equal to unequal teeth, distinctly tridentate; middle lobe of the lower corolla-lip acute. .... 248. *P. nasturtiifolia*
  - BB. Leaves pinnatisect, the segments 6-9 on each side.
    - C. Pedicels to 6 cm. long; calyx-teeth lanceolate, subentire to obscurely dentate. .... 249. *P. longipes*
    - CC. Pedicels 0.5-2 cm. long; calyx-teeth ovate-oblong. ..... 250. *P. axillaris*



Map 41.—Distribution of the series Longipedes and Omiianae.

AA. Leaves mostly alternate or only those of the lower part of the stem opposite or subopposite.

B. Leaflets 9-12-paired; calyx not cleft anteriorly, the teeth distinctly tridentate; middle lobe of the lower corolla-lip rounded. .... 251. *P. laxiflora*

BB. Leaflets 6-8-paired; calyx slightly or deeply cleft anteriorly, the teeth obscurely dentate; middle lobe of the lower corolla-lip acute or rounded.

C. Calyx slightly cleft anteriorly; corolla-tube longer than the calyx; middle lobe of the lower lip acute; staminal filaments all glabrous. 252. *P. membranacea*

CC. Calyx deeply cleft anteriorly; corolla-tube shorter than the calyx; middle lobe of the lower lip rounded; staminal filaments all hairy. 253. *P. aquilina*

247. Pedicularis filicifolia Hemsley Plate 13, fig. 203.

Pedicularis filicifolia Hemsl. ex Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 208, 1890; Diels, in Bot. Jahrb., 29: 571, 1900; Bonati, in Bull. Soc. Bot. France, 54: 185, 1907; Limpricht, in Repert. Sp. Nov., 20: 257, 1924; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 211, 1934. Hemsley's type was from "Hupeh: S. Patung (*A. Henry*, 6105!). Herb. Kew." An isotype is in the Gray Herbarium. Hemsley also mentioned that "No. 6980, Hupeh, Hsingshan, in fruit, may be a variety; but has narrower leaves with 9 pairs of segments." This number is found to be identical with other specimens here designated as *P. laxiflora*.

In woods in western Hupeh. Flowers purple (?). Flowering in July.

HUPEH: Patung, *Henry* 6105 (GH), *Wilson* 2319 p.p.[14] (USNH).

This species has almost wholly opposite or rarely subopposite leaves. The leaflets are 3-5-paired and ovate-oblong. It is related to *P. laxiflora*, *P. nasturtiifolia*, and *P. membranacea*, especially in the general floral structures. However, the arrangement and especially the shapes of the leaves, although the latter are variable in size, are useful in distinguishing these related species. An illustration showing the typical leaves of these species is given (text-figure 6).

P. filicifolia is also characterized by the slender pedicels which are about 1.5 cm. long, twice the length of the calyx; the calyx has one posterior tooth that is oblong-linear, slightly 3-dentate toward the apex, and 4 lateral ones that are foliaceous, broad, and 3-5-dentate.

248. Pedicularis nasturtiifolia Franchet Plate 13, fig. 204.

Pedicularis nasturtiifolia Franch., in Bull. Soc. Bot. France, 47: 28, 1900; Diels, in Bot. Jahrb., 29: 571, 1900; Limpricht, in Repert. Sp. Nov., 20: 257, 1924. Franchet's type was from "Su-tchuen, à Han-ky-se, près de Tchen-keou-tin, dans les lieux humides, alt. 2000 m. (Farges)." Isotypes from the Bonati Herbarium are at the Academy of Natural Sciences of Philadelphia and the University of California at Los Angeles.

In moist places at an altitude of about 2000 meters in eastern Szechuan. Flowers rose. Known from the original collection only.

SZECHUAN: Tchen-keou-tin, *Farges* s.n. (ANSP, UCLA).

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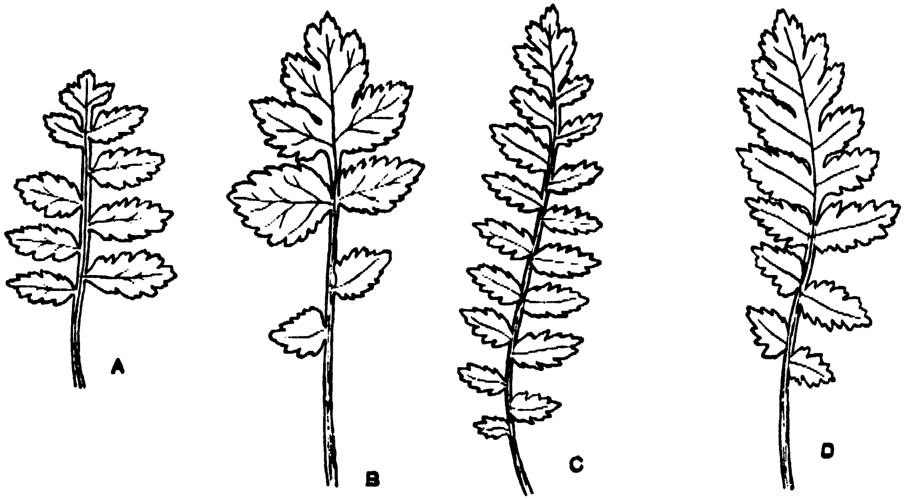
[14] Wilson 2319 is apparently a composite collection. The specimen in the United States National Herbarium consists of two elements: (a) *P. filicifolia* and (b) *P. laxiflora*. The specimens in the Bonati Herbarium (ex Kew) and the New York Botanical Garden have each a single element which is *P. laxiflora*. Bonati (in Bull. Soc. Bot. France, 54: 185, 1907) identified these same two species from *Wilson* 2319, but Limpricht (in Repert. Sp. Nov., 20: 257, 1924) identified *P. nasturtiifolia* in addition to these two species.



Text-figure 6.—Leaves of the series Longipedes. A, *P. filicifolia* Franch. B, *P. nasturtiifolia* Franch. C, *P. laxiflora* Franch. D, *P. membranacea* sp. nov.

This species is related to *P. longipes, P. laxiflora, P. filicifolia,* etc. It is characterized by the leaves on the long slender branches being mostly opposite and subopposite, only those toward the tip of the stem being alternate. The leaves are pinnatisect and usually pinnatifid toward the apex, the segments 2-4-paired and very broad-ovate. The pedicels range from 7-8 mm. long, about equaling the calyx in length, to about 2 cm. long. The 5 calyx-teeth are more or less subequal, foliaceous, broad, and 3-5-dentate. The middle lobe of the lower corolla-lip is characteristically acute in its apex.

249. **Pedicularis longipes** Maximowicz

Pedicularis longipes Maxim., in Bull. Acad. St. Pétersb., 32: 554, fig. 38, 1888; in Mél. Biol., 12: 824, fig. 38, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 212, 1890; Limpricht, in Repert. Sp. Nov., 20: 257, 1924. The type, "Prov. Sze-tschuan parte boreali, monte Kungala inter custodia Tashitu et Dshindshetan (Potanin, 1885)," has not been seen. The type locality is in northwestern Szechuan, north of Sungpan, close to the Kansu border.

In northern Szechuan. Flowers rose. Known from the original collection only. No specimen seen.

According to Maximowicz this species is very close to *P. axillaris,* being characterized by the long pedicels which often attain a length of 6 cm. The leaves are alternate on the stem but opposite on the branches, long-petiolate, membranaceous, and pinnatisect with 7-9 paired, ovate to oblong, pinnatifid and mucronate-dentate segments. The calyx has 5 lanceolate-linear, acuminate teeth, often sparsely denticulate toward the tip.

250. Pedicularis axillaris Franchet

Key to the Varieties

A. Corolla purple. .... 250a. *P. a. typica*
AA. Corolla greenish white. .... 250b. *P. a. balfouriana*

250a. Pedicularis axillaris typica Plate 13, fig. 205.

Pedicularis axillaris Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 555, fig. 39, 1888; in Mél. Biol., 12: 825, fig. 39, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 205, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 82, 1911; 7: 148, 241, 1912; 8: 39, 1913; 15: 164, 1926; Limpricht, in Repert. Sp. Nov., Beih. 12: 484, 1922; in Repert. Sp. Nov., 20: 257, 1924; 23: 338, 1927; Hand.-Maz., Symb. Sin., 7: 865, 1936. A duplicate of the type, "Prov. Yunnan: monte Tsang-schan supra Tali (Delavay!)," is in the Bonati Herbarium. This is *Delavay* 955, and will pass to the University of California at Los Angeles.

Pedicularis heterophylla Bonati, in Bull. Bot. Soc. France, 55: 244, 1908; Limpricht, in Repert. Sp. Nov., 20: 258, 1924. Bonati's type was from Sikang: "Yargong, dans les forêts (*R. P. Soulié*), nº 3348, 1903." An isotype from the Bonati Herbarium passes to the University of California at Los Angeles. This is an exact match of *P. axillaris* and is clearly identical with it. Bonati described the plant as having glabrous pedicels, but the specimen shows clearly the slight hairiness. He also described the anterior filaments as hirsute basally, which character he used in later years to distinguish the species from *P. axillaris*. However, in the available type specimen the filaments are found to be glabrous. Occasionally in some specimens of *P. axillaris* the filaments do bear a few sparse hairs.

Pedicularis lacerata Bonati, in Notes Bot. Gard. Edinb., 13: 110, 1921; Limpricht, in Repert. Sp. Nov., 20: 258, 1924. Bonati's type was from northwestern Yunnan: "'A-tun-tsu. Alt. 13,000 ft. In dense shade in forest and shrub belt. August 1913.' F. Kingdon Ward. No. 935." The type in the Edinburgh Herbarium has been seen. A photograph is in the herbarium of the Academy of Natural Sciences of Philadelphia. The type shows clearly that this species is identical with *P. axillaris*.

In moist pastures or shady, damp situations in forests and thickets or by stream side, sometimes in open rock crevices at altitudes of 3000 to 4000 meters in northwestern Yunnan and Sikang. Flowers pinkish purple. Flowering from June to August.

SIKANG: Yargong, *Soulié* 3348 (UCLA); Glacier Lake, *Ward* 4698 (RBGE); Mt. Mitzuga, west of Muli Gomba, *Rock* 16535 (ANSP, USNH); Tsa-wa-rung, Chi-na-tung, *C. W. Wang* 65320 (AA).

YUNNAN: no precise localities, *Forrest* 7166 (UCLA), *Yü* 12601 (AA), 12819 (AA); Tsang-chan supra Tali, *Delavay* 955 (UCLA); Kou toui, Mosoyn, *Delavay* s.n. (ANSP, NYBG, UCLA, USNH); eastern flank of the Tali Range, *Forrest* 4485 (ANSP, NTU, UCLA); Yangtze-Youngning divide, *Forrest* 12469 (ANSP, UCLA); Chien-chuan-Mekong divide, *Forrest* 21958 (USNH); A-tuno-tzu, *Ward* 935 (RBGE); eastern slopes of Mt. Dyinaloko, northern peak of Likiang Snow Range, *Rock* 9011 (UC, GH, USNH); eastern slopes of Likiang Snow Range, Yangtze watershed, *Rock* 4107 (USNH), 4515 (NYBG, USNH), 4870 (USNH), 9054 (ANSP, USNH); Yulung Shan, near Kikiang, *Handel-Mazzetti* 6804 (USNH); Litiping, between Likiang and Weisi, *Forrest* 19457 (ANSP, UCLA), *Ching* 20898 (AA); northern flank of Haba Snow Range, *Feng* 1323 (AA); Lan-ping District, *Tsai* 53786 (AA); Sila, Mekong-Salween divide, *Yü* 22233 (AA); Che-tse-lo, Pi-lo-shan, *Tsai* 58130 (AA); Ta-li District, *Tsai* 53865 (AA), 53872 (AA), 53930 (AA); Wei-si District, *C. W. Wang* 64073 (AA), 68508 (AA), 68370 (AA).

This species is usually long-branched, with very slender, trailing or ascending branches. The leaves are strictly opposite in most cases but not infrequently they are suboppositely arranged. In young flowers the margins of the lower corolla-lip are ciliate but in mature flowers these margins are only sparsely ciliate or glabrous. The capsules, as observed in many of the specimens, are very short, compressed-ovoid, about 8 mm. long and 7 mm. broad, strongly obliquely acute at the apex and almost wholly enclosed in the calyx. The pedicels apparently increase in length from flower to fruit and often attain to a length of 2 cm.

250b. Pedicularis axillaris balfouriana comb. nov.

Pedicularis balfouriana Bonati, in Notes Bot. Gard. Edinb., 5: 82, pl. 71, 1911; 7: 241, 1912; Limpricht, in Repert. Sp. Nov., 20: 257, 1924. Bonati's type was from Yunnan: "'Open, stony pastureland on the eastern flank of the Tali Range. Lat. 25° 40′ N. Alt. 9-10,000 ft. June 1906.' G. Forrest. No. 4489." This is in the Edinburgh Herbarium and has been seen. A photograph is in the herbarium of the Academy of Natural Sciences of Philadelphia.

Open pastureland at altitudes of about 2750 to 3350 meters in northwestern Yunnan. Flowers greenish white. Flowering in June. Known from the original collection only.

YUNNAN: eastern flank of the Tali Range, *Forrest* 4489 (RBGE).

This variety can be distinguished from the typical form of the species by its habit, which is lower, many-branched at base only, and by its very long-petiolate bipinnatisect leaves, as well as by its greenish white corolla. Bonati mentioned only that the radical leaves are opposite. In the specimen the upper leaves are shown to be subopposite to alternate.

251. Pedicularis laxiflora Franchet Plate 13, fig 206.

Pedicularis laxiflora Franch., in Bull. Soc. Bot. France, 47: 27, 1900; Diels, in Bot. Jahrb., 29: 571, 1900; Bonati, in Bull. Herb. Boiss. II, 7: 544, 1907; in Bull. Soc. Bot. France, 54: 185, 1907; Limpricht, in Repert. Sp. Nov., 20: 257, 1924. Franchet's type was from "Su-tchuen, autour de Tchen-keou-tin." This was apparently a number of Farges, although Franchet did not mention it. Bonati (in Bull. Herb. Boiss. II, 7: 544, 1907) cited *Farges* 1170 from the same locality which may be the type collection. In the New York Botanical Garden, there is a Farges specimen, without number, from the type locality. In the Bonati Herbarium there are two Farges collections from "Sutchuen or.," ex Herbier de M. de Coincy, which will pass to the Academy of Natural Sciences of Philadelphia and the University of California at Los Angeles. These three specimens agree very well with all others here cited and they are evidently conspecific. However, these specimens have calyces and corollas that are smaller than the measurements given by Franchet; otherwise they conform closely to Franchet's description, especially in the 8-10-paired leaflets. Franchet stated that the leaves of the stem are alternate, rarely the lower opposite, but that those on the branches are opposite. Among the specimens here observed the leaves are mostly alternate except the lower ones which are opposite or subopposite. It may be that some of the plants here referred to as *P. laxiflora* may be more appropriately called a variety of the species, but inasmuch as authentic type specimens of the species have not been seen a tentative treatment is to place all of them as belonging to the species proper.

In eastern Szechuan and western Hupeh. Flowers rose. Flowering in June and July.

WESTERN CHINA: no precise locality, *Wilson* 4233 (ANSP).

HUPEH: no precise locality, *Henry* 6980 (GH), *Wilson* 2319 p.p.[15] (ANSP, NYBG, UCLA).

SZECHUAN: eastern Szechuan, *Farges* s.n. (ANSP, UCLA); Tchen-kéou-tin, *Farges* s.n. (NYBG).

This species can be distinguished from its allies by its membranaceous, pinnatisect leaves, the segments being 8-10-paired, ovate-oblong to ovate-lanceolate. The pedicels are 1 to 1.5 cm. long. The calyx has 5 teeth, the teeth more or less ovate and 3-5-dentate, the posterior one being smaller.

252. **Pedicularis membranacea** sp. nov. Plate 13, fig. 207.

Annua (?); radice gracili; caulibus singulis gracilibus debilibus, probabiliter decumbentibus, glabrescentibus vel pubescentibus, circiter 4.5 dm. longis, apicem versus valde gracilibus, flexuosis; foliis radicalibus deciduis (?), caulinis alternis, superioribus valde minoribus, inferioribus magnis, membranaceis, longe petiolatis (petiolis gracilibus, 2-6 cm. longis), utrinque glabris vel supra sparse hirsutis, ovato-oblongis, ad 7-10 cm. longis 3-3.5 cm. latis, pinnatisectis, apicem versus saepe profunde pinnatifidis, segmentis 6-8-jugis, sessilibus, ovatis vel ovato-oblongis, circiter 1.5 cm. longis 1.1 cm. latis, acutis vel obtusis, leviter pinnatifidis serratisque basi valde latis; floribus omnino axillaribus, singulis vel 3-4-conjunctis, pedicellis gracilibus, circiter 5 mm. longis, fructigeris ad 1.2 cm. longis; calyce campanulato 4-5 mm. longo, 10-costato, inferne leviter hirsuto, haud reticulato, antice subfisso, 5-dentato, dentibus subaequalibus vel aequalibus, posteriore leviter parvo, caeteris ovatis, stipitatis, obscure serratis; corollā (immaturā) purpureā: tubo calycem duplo longiore, erecto; galeā in rostrum distinctum productā; labio inferiore circiter 9 mm. longo, in junioribus margine ciliato, 3-lobato, lobis lateralibus rotundatis, lobo medio acuto, parvo, porrecto; staminibus tubo insertis, filamentis glabris; stylo paulo exserto; capsulis crassis, compresso-ovoideis, ad 7 mm. longis 5 mm. latis, apice valde oblique acutis, calyce inclusis.

Type, on moist rocky slope under tree shade at an altitude of about 2400 meters, near Ta Kwan, Ta Hsiang Ling, Kanting, Sikang Province, collected in flower and fruit, Aug. 7, 1937, by C. Y. Chiao, No. 1657; holotype in the herbarium of the Arnold Arboretum.

Mountain slopes at altitudes of 2300 to 2400 meters in eastern Sikang. Flowers purple. Flowering in August.

SIKANG: Kanting, near Ta Kwan, Ta Hsiang Ling, *Chiao* 1657 (AA); Kanting, Tsio-hai-ping, *Chiao* 2081 (AA).

Only immature flowers are found but clearly a distinct species is represented. The leaves are all alternately arranged, long-petiolate, and pinnatisect, with 6-8 pairs of leaflets. In the leaf characters it is intermediate between *P. nasturtiifolia* and *P. laxiflora*, the leaflets of the former being mostly 3-4-paired and the latter 9-12-paired. It is further related to *P. nasturtiifolia* in the acute middle lobe of the lower corolla lip. But in *P. nasturtiifolia* the leaves are opposite or subopposite and fewer segmented, the calyx is not cleft anteriorly and has more or less equal, much broader and more distinctly tridentate teeth.

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[15] See footnote under *Wilson* 2319 of *P. filicifolia* Hemsl.

253. Pedicularis aquilina Bonati

Pedicularis aquilina Bonati, in Bull. Bot. Soc. France, 55: 245, 1908; Limpricht, in Repert. Sp. Nov., 20: 238, 1924. The type from "Yunnan (*R. P. Doucloux*) sans n° (herb. Mus. Paris)," has not been seen.

Yunnan. Flowers purple. Known from the original collection only. No specimen seen.

Limpricht with uncertainty assigned this species to the series Racemosae because Bonati had originally, but also doubtfully, referred it to the Resupinatae, a group to which it is evidently not related. Bonati had also suggested relationship to *P. axillaris*. In 1911 he included this species with *P. vagans* in the series Vagantes (in Bull. Soc. Bot. France, 57, Mém. 18: 25, 1911). Although Bonati did not include this in his key to the species of the series Longipedes (in Notes Bot. Gard. Edinb., 13: 113-114, 1921), the original description clearly reveals that it should be referred here. The axillary flowers, long pedicels, etc., definitely suggest relationship with *P. axillaris*. The species is described as having alternate pinnatisect leaves, anteriorly cleft calyx with 5 flabellate teeth, short corolla-tube included in the calyx, horizontal beak, and wholly villose filaments.

Series 74. Omiianae ser. nov.

Plant perennial; stems single or several together, simple, erect to procumbent, glabrous to sparsely hairy; leaves radical and cauline, dissimilar, the radical leaves larger and longer-petiolate, pinnatisect, the segments 11-15 on each side, ovate-oblong, incised-dentate, the cauline leaves smaller, alternate and opposite to subopposite, ovate, pinnatifid, the base cordate, the lobules not incised; flowers all axillary, short-pedicellate; calyx cylindric-campanulate, scarcely reticulate, 5-dentate, the teeth subequal, filiform to scarcely dilated distally, entire to subentire or serrate; corolla-tube long, erect, to 4 times as long as the calyx, slightly hairy distally; galea erect, obtusely curved, produced attenuately into a cylindric beak, erect and upraised; lower lip deeply 3-lobed, the lobes rounded, the margins glabrous, the middle lobe slightly larger and more distad; stamens inserted at the throat of the tube, the filaments glabrous; capsules unknown.

One species in southwestern Szechuan (Map 41).

The species *P. omiiana* was placed by Bonati in the Longipedes. Its long-tubular corolla and dissimilar radical and cauline leaves are very distinct. It is here made into a separate series which is clearly more closely related to the Musicolae than the Longipedes. The radical leaves are not very large in size and are similar to the leaves of *P. macrosiphon*. In the leaf-character this series is somewhat intermediate between the Muscicolae and species like *P. vagans* which has very large radical leaves.

254. Pedicularis omiiana Bonati

Key to the Varieties

A. Stems erect to decumbent; petioles puberulous; leaves to 2 cm. wide, the segments all sessile, decurrent; calyx-teeth narrower, entire to subentire. 254a. *P. o. typica*

AA. Stems procumbent; petioles and the lower mid-rib villose; leaves to 2.5 cm. wide, the segments nearly petiolulate; calyx-teeth broader, serrate. .. 254b. *P. o. diffusa*

254a. Pedicularis omiiana typica Plate 13, fig. 208.

Pedicularis omiiana Bonati, in Bull. Soc. Bot. France, 54: 184, 375, 1907; Limpricht, in Repert. Sp. Nov., 20: 257, 1924; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 215, 1934. The type, " [Wilson] N° 5079, mont Omi, juin 1904," was from western Szechuan. An isotype from the Bonati Herbarium passes to University of California at Los Angeles. The label reads: "Western China. Mt. Omi. Coll. E. H. Wilson, No. 5079. 6/04."

In western Szechuan. Flower color unknown. Flowering in June.

SZECHUAN: Mt. Omei, *Wilson* 5079 (UCLA).

This species, together with its variety, has a flower resembling that of *P. macrosiphon,* but it bears a larger and more slender beak which is distinctly upraised and has a hairy corolla-tube. From this species and its allies it can be readily distinguished by its larger pinnatisect radical leaves and much smaller pinnatifid cauline leaves.

254b. Pedicularis omiiana diffusa Bonati

Pedicularis omiiana Bonati var. *diffusa* Bonati, in Bull. Soc. Bot. France, 54: 185, 376, 1907; Limpricht, in Repert. Sp. Nov., 20: 257, 1924. A specimen of " [Wilson] N° 4235," the type, is in the Bonati Herbarium, from which it passes to the University of California at Los Angeles. The label reads: "Western China. Mt. Wa. 10700 ft. Coll. E. H. Wilson. No. 4235. 7/03."

At an altitude of about 3200 meters in western Szechuan. Flowering in July. Known from the original collection only.

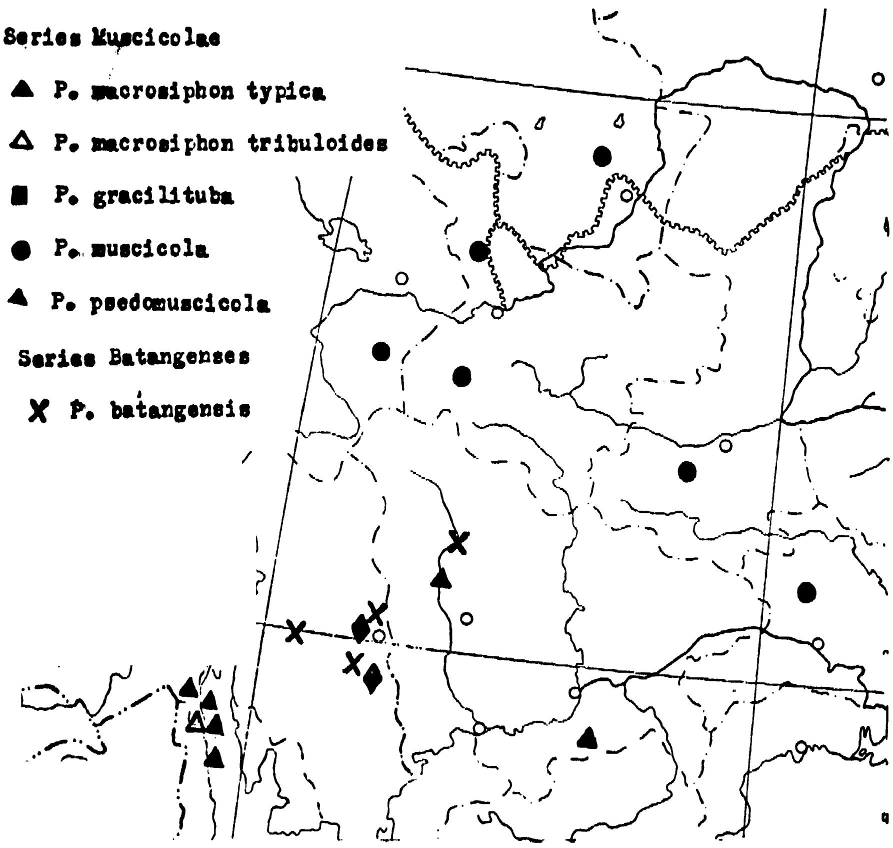
SZECHUAN: Mount Wa, *Wilson* 4235 (UCLA).

Series 75. Muscicolae

Muscicolae Maxim., in Bull. Acad. St. Pétersb., 32: 535, 1888, p.p.; in Mél. Biol., 12: 797, 1888, p.p.; Prain, in Ann. Bot. Gard. Calcutta, 3: 68, 1890.

Low or medium-sized plants; stems usually many, very slender, procumbent to erect, pubescent or glabrous; leaves mostly cauline, alternate to opposite or subopposite, the petioles long and slender, the blades ovate to linear-oblong, pinnatisect, the lobes remote, narrowed or broad at base, pinnatifid to serrate; flowers axillary, scattered, usually few, with long or short pedicels; calyx cylindric-campanulate, rarely cleft anteriorly, with prominent nerves, not or only slightly reticulate distally, 5-dentate, the teeth subequal to equal, elongate, usually slightly narrowed proximally, serrate to rarely subentire distally; corolla rose to purple, long-tubular, the tube slender, 3-5 or more times as long as the calyx, erect, glabrous or pubescent externally; galea falcate, twisted or not, produced into a conical or filiform beak, the beak straight, bending or sigmoid; styles included or the apices slightly exserted; stamens inserted at the apex of the tube, the filaments all glabrous; capsules unknown.

About 4 or 5 species from northwestern Yunnan to Sikang, eastern Chinghai, Szechuan, Kansu, Ninghsia, Shensi and Shansi (Map 42).



Map 42.—Distribution of the series Muscicolae and Batangenses.

The relationship of this series is clearly with the Longipedes. The species have similar slender stems, same types of leaves which are similarly alternately arranged but sometimes with opposite or subopposite arrangement, and scattered axillary flowers usually with long pedicels. This series differs from the Longipedes chiefly in the very long corolla-tube and also in the glabrous-margined lower lip and glabrous filaments.

Key to the Species

A. Galea not twisted, the beak long or short, filiform to conical, 2-7 mm. long, more or less straight, sometimes slightly bending, never sigmoid; pedicels shorter, scarcely to 1 cm. long; leaves less finely dissected, the segments ovate to ovate-oblong, serrate to pinnatifid.

B. Plant more or less densely pubescent, to 1.5-2.5 dm. or more tall; corolla-tube to 4-5 cm. long, glabrous externally, the beak short, conical, to 2-3 mm. long. .... 255. *P. macrosiphon*

BB. Plant glabrous or sparsely pubescent, to 1.1 dm. tall; corolla-tube to 7 cm. long, pubescent externally, the beak subfiliform, to 5 mm. long. 256. *P. gracilituba*

AA. Galea twisted, the beak very long, 6-15 mm. or more in length, filiform, very slender and sigmoid; pedicels 1.5-8 cm. long; leaves more finely dissected, the segments ovate-oblong to lanceolate to deeply pinnatifid.

B. Leaf-segments lanceolate, 2-4 mm. wide; calyx not cleft anteriorly; pedicels 1.5-2.5 cm. long; beak longer, about 15 mm. long; lower lip with a much smaller oblong middle lobe. .... 257. *P. muscicola*

BB. Leaf-segments ovate-oblong, about 7 mm. wide; calyx cleft anteriorly; pedicels 5-8 cm. long; beak shorter, about 6-10 mm. long; lower lip with subequal lobes, the middle lobe rounded. .... 258. *P. pseudo-muscicola*

255. Pedicularis macrosiphon Franchet

Key to the Varieties

A. Plant tall, 2.5 dm. or more tall, the stems spreading-ascending; leaves larger, 4-6 cm. or more long, the segments broader, about 5 mm. wide. ... 255a. *P. m. typica*

AA. Plant low, scarcely to 1.5 dm. tall, the stems spreading, forming a dense cushion; leaves smaller, to 3.5 cm. long, the segments narrower, about 2-4 mm. wide. 255b. *P. m. tribuloides*

255a. Pedicularis macrosiphon typica Plate 13, fig. 209.

Pedicularis macrosiphon Franch., in Nouv. Arch. Mus. Nat. Hist. Paris II, 10: 66, 1888 (Pl. David. II); Maxim., in Bull. Acad. St. Pétersb., 32: 535, fig. 14, 1888; in Mél. Biol., 12: 798, fig. 14, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 212, 1890; Diels, in Bot. Jahrb., 29: 671, 1900; 36, Beibl., 82: 96, 1905; Bonati, in Bull. Herb. Boiss. II, 7: 544, 1907; Limpricht, in Repert. Sp. Nov., Beih. 12: 484, 1922; in Repert. Sp. Nov., 20: 254, 1924; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 214, 1934; Hand.-Maz., Symb. Sin., 7: 865, 1936.[16] The type was from southwestern Szechuan: "Moupine, in campis lepidosis et secus torrentes [*David*]. Fl. Jun. 1869." Maximowicz's illustration and redescription were based on two collections: *David* s.n. and *Potanin* s.n. from Kansu. The latter identification, repeated also by Limpricht (l.c., 1924), however, is doubtful, as the range is beyond the extent of this species and the plant is possibly *P. muscicola*.

Pedicularis lucifuga Bonati, in Notes Bot. Gard. Edinb., 13: 112, 1921; Limpricht, in Repert. Sp. Nov., 20: 257, 1921. The type was from Sikang near the Yunnan border: "'S.E. Tibet:—On Ka-gwr-pw, Mekong-Salween divide. Shady pasture on the margins of pine forests. Lat. 28° 25′ N. Alt. 10,000 ft. Plant of 6-16 ins. Flowers rose, beak darkest. July 1917.' G. Forrest. No. 14,200." An isotype in the Bonati Herbarium will divide between the Academy of Natural Sciences of Philadelphia, the University of California at Los Angeles, and the National Taiwan University. Bonati described the margins of the lower corolla-lip as ciliate and two of the staminal filaments as hairy. But the available specimen shows that the lower lip is glabrous on the margins and the filaments are all glabrous. This species is clearly the same as *P. macrosiphon*. It frequently has opposite and alternate leaves on the same stem.

Moist shady places in woods or ravines at altitudes of 1200 to 3400 meters, in northwestern Yunnan, Sikang, and Szechuan. Flowers rose. Flowering from May to August.

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[16] Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 33, 1933, identified *Rock* 12293 as this species, but the specimen proves to be *P. muscicola* Maxim.

SZECHUAN: Nan-chuan District, *Fang* 1212 (ANSP, GH, USNH), 1368 (GH); Wenchuan District, *F. T. Wang* 20919 (AA).

SIKANG: Tsekou, Patong, *Soulié* 1483 (ANSP, NTU, UCLA); Ka-gwr-pw, Mekong-Salween Divide, *Forrest* 14200 (ANSP, NTU, UCLA).

YUNNAN: no precise localities, *Monbeig* s.n. (ANSP, UCLA), *Yü* 8583 (AA); Wei-si District, Kang-pu, *C. W. Wang* 64399 (AA); Wei-si District, Yeh-chih, *C. W. Wang* 68049 (AA), 68090 (AA); Atuntse, Huann-fu-ping, *C. W. Wang* 64720 (AA), 69161 (AA), 69264 (AA); Mekong-Salween divide, Tsechung, *Yü* 19015 (AA).

A long, slender and diffuse-ascending species, with frequently opposite and subopposite leaves below and alternate leaves above. There are often a few large leaves at the base or sometimes on the upper part of the stem as well. The plant is generally greyish pubescent. The species is characterized by the glabrous corolla-tube and the short conical beak.

Franchet originally described the calyx-teeth as subequal, foliaceous, pedicellate, and denticulate. He did not mention whether the calyx is cleft or not. Maximowicz's redescription characterized the calyx as " semifisso " and the posterior tooth as small, deltoid, and entire. In the various specimens examined, Franchet's original characterization rather than Maximowicz's modification has been observed.

255b. **Pedicularis macrosiphon** var. **tribuloides** (Bonati) comb. nov.

Pedicularis tribuloides Bonati, in Notes Bot. Gard. Edinb., 13: 111, 1921; Limpricht, in Repert. Sp. Nov., 20: 257, 1924. The type was from: "' West China:—Salween Valley. Margins of thickets, by streams. Lat. 28° 10′ N. Alt. 10,000 ft. Plant of 6-10 ins. Flowers rose. June 1917.' G. Forrest. No. 16,207." This is probably located along the Yunnan-Sikang border. An isotype from the Bonati Herbarium divides between the Academy of Natural Sciences of Philadelphia and the University of California at Los Angeles.

Margins of thickets by streams at an altitude of about 3500 meters in northwestern Yunnan near the Sikang border. Flowers rose. Flowering in June. Known from the original collection only.

YUNNAN: Salween Valley, *Forrest* 16207 (ANSP, UCLA).

This variety is very near *P. macrosiphon typica* especially in the glabrous corolla-tube and short conical beak. It is, however, a much lower plant with spreading stems and branches. The leaves are smaller and with narrower segments.

256. **Pedicularis gracilituba** sp. nov.

Key to the Varieties

A. Leaves glabrous to very sparsely setose above. .... 256a. *P. g. typica*
AA. Leaves densely setose above. .... 256b. *P. g. setosa*

256a. **Pedicularis gracilituba** typica Plate 13, fig. 210.

Planta nana, glabrata vel parce pubescens, caespitosa, 4-6 interdum vix 11 cm. alta; radice crassā; caulibus multis, gracilibus, flexuosis, procumbentibus, simplicibus, foliatis; foliis basalibus caulinisque, inferioribus

majoribus exceptis similibus, alternis, longe petiolatis, petiolis gracilibus, flexuosis, 1-2 interdum ad 4 cm. longis, laminis membranaceis, glabris vel interdum supra setosis, ovato-oblongis vel lineari-oblongis, 2.5-3.5 cm. longis, 0.7-2 cm. latis, pinnatisectis, segmentis utrinsecus 4-6, remotis, ovatis vel ovato-oblongis, ad 5 mm. latis, acutis, basi constrictis, pinnatifidis vel distincte serratis; floribus axillaribus, paucis; pedicellis gracilibus ad 1 cm. longis; calyce cylindrico-campanulato, 7-10 mm. longo, pubescente, nervis prominulis, haud reticulatis, dentibus 5 subaequalibus, basi constrictis, superne ovatis, subintegris vel serratis; corollā purpureā, ad 7 cm. longā: tubo longo, erecto, gracili, ad 6.5 cm. longo, externe pubescente, superne haud dilatato; galeā falcatā, parte verticali 2-3 mm. longā, parte horizontali 2-3 mm. longā, apice in rostrum productā; rostro subfiliformi, recto, ad 5 mm. longo, apice truncato; labio inferiore circiter 1 cm. longo et 1.3 cm. lato, margine glabro, 3-lobato, lobis subaequalibus, rotundatis, lobo medio porrecto; staminibus ad apicem tubi insertis, filamentis glabris; stylo haud exserto; capsulis ignotis.

Type, in meadows and clearings at an altiude of 4000 meters in the mountains of Kulu, Muli Territory, Sikang Province, collected in flower, June 1929, by J. F. Rock, No. 18066; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotype in the United States National Herbarium.

Alpine meadows at altitudes of 3850 to 4000 meters in southeastern Sikang. Flowers purple. Flowering in June and July.

SIKANG: Muli Territory, mountains between the Litang and Yalung Rivers, between Muli Gomba and Baurong and Wa-Erh-Dje, *Rock* 16616 (ANSP, USNH); Muli Territory, mountains of Kulu, *Rock* 18066 (ANSP, USNH).

A species allied to *P. macrosiphon.* It differs, however, in being a smaller plant with glabrous habit, shorter stems and smaller leaves. The corolla-tube is somewhat longer and pubescent instead of glabrous externally. The beak is also longer and more slender.

256b. **Pedicularis gracilituba setosa** var. nov.

A typo speciei differt caulibus paucis; foliis supra dense setosis.

Type, in northwestern Yunnan, field data not available, collected in flower by T. T. Yü, No. 12060; holotype in the herbarium of the Arnold Arboretum.

In northwestern Yunnan. Flowers purple.

YUNNAN: northwestern Yunnan, precise locality unknown, *Yü* 6597 (AA), 12060 (AA).

Differs from the typical form of the species in the few-stemmed, sparse habit, and in the densely setose leaf-segments. It is found in regions adjacent to the range of the typical form although the exact localities of the collection are unknown.

257. Pedicularis muscicola Maximowicz Plate 13, fig. 211.

Pedicularis muscicola Maxim., in Bull. Acad. St. Pétersb., 24: 54, 1878; 32: 535, fig. 13, 1888; in Mél. Biol., 10: 84, 1878; 12: 798, fig. 13, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 213, 1890; Limpricht, in Repert. Sp. Nov., Beih. 12: 484, 1922; in Repert. Sp. Nov., 20: 253, 1924; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 34, 1933; Walker, in Contr. U. S. Nat. Herb., 28: 659, 1941. The types were from various localities in northwestern China: "In Chinae prov. Kansu, ejusdem jugi ut praecedens silvis acerosis et frondosis solo humido muscoso frequens (Przewalski), in ejusdem provinciae parte australi, nec non in prov. Schensi parte boreali (Piasczki). In Mongoliae australis jugo Alaschan, silvis muscosis rarius (Przewalski)." A duplicate of the first syntype, bearing Maximowicz's handwriting, "*Pedicularis muscicola* Maxim. China, Kansu orientalis, 31, V. 1885. Determ. Maximowicz. Legit N. M. Przewalski," is in the Bonati Herbarium; it divides between the University of California at Los Angeles and the Academy of Natural Sciences of Philadelphia.

"*Pedicularis macrosiphon*" *sensu* Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 33, 1933; *non* Franch. Determination based on *Rock* 12293.

In moist and dense shade under woods in valley or along streams, at altitudes of 1750 to 2650 meters in western Hupeh, Shansi, Shensi, Ninghsia, and eastern Chinghai. Flowers purplish crimson. Flowering in May, June, and July.

KANSU: eastern Kansu, *Potanin* s.n. (Dehra Dun), *Przewalski* s.n. (ANSP, UCLA); Choni, *Farrer* 172 (RBGE); T'ao River basin, Choni, *Rock* 12293 (ANSP, GH, NYBG); Toul Ping, near Li-chen, Ping Fan, *Ching* 423 (ANSP, USNH).

NINGHSIA: Ho Lan Shan mountains, *Ching* 1129 (ANSP, USNH).

CHINGHAI: Ba Valley, *Rock* 14279 (ANSP, GH).

SHANSI: Tung Tsa, *Lee* 5567 (UC), *Lowdermilk* 2013 (UC); Fan Shan, Kwen-ti Shan, *Ling* 9416 (UC); Lin-shih District, Mien Shan, *Tang* 915 (ANSP, NYBG, USNH).

SHENSI: Kin-tsu Shan, *Giraldi* 5529 (ANSP, UCLA).

HUPEH: western Hupeh, *Wilson* 2603 (NYBG).

This is a very showy plant. It is low and many-branched, with the branches spreading and forming a cushion sometimes to several feet square. The numerous long-tubular flowers are erect and rich purple crimson in color. The species is especially characterized by the twisted galea and the long slender sigmoid beak. Maximowicz, however, did not describe nor depict the twist of the galea. He also did not show that the tube is sparsely hairy externally especially toward the distal part.

258. Pedicularis pseudo-muscicola Bonati Plate 13, fig. 212.

Pedicularis pseudo-muscicola Bonati, in Bull. Soc. Bot. France, 54: 371, 1907; Limpricht, in Repert. Sp. Nov., 20: 254, 1924. Bonati failed to cite any specimen at the end of the description; he simply listed "Habit: ", with nothing following. But, as we fortunately learn from the introductory remarks to his paper, he based this species on a collection of *Soulié*. This was in all probability from eastern Sikang where Soulié's other collections were made. In the Bonati Herbarium there is a specimen named *Pedicularis pseudo-muscicola* in Bonati's own handwriting, *Soulié* 977, from "Ta-tsien-lou, (Principauté de Kiala)," collected in 1893, which is presumably an isotype; it divides between the Academy of Natural Sciences of Philadelphia and the University of California at Los Angeles.

In Sikang, at altitudes of 2800 to 3700 meters. Flowers purple. Flowering in August and September.

SIKANG: Tatsienlu, *Soulié* 977 (ANSP, UCLA); Tatsienlu to Sachou, via Mouping, *Stevens* 77 (CM).

In the long-tubular corolla with its twisted galea and sigmoid beak this species is clearly related to *P. muscicola.* The tube is also hairy externally. It differs, however, in the smaller leaves with broader segments, the cleft calyx and the shorter beak. Its range lies south of that of *P. muscicola.*

Series 76. Batangenses ser. nov.

Low plants, the stems many-branched at base, the branches long, decumbent; leaves opposite, rarely subopposite, pinnatisect, the segments oblong, deeply pinnatifid, remote; flowers all axillary, scattered, pedicellate, the pedicels about as long as the calyx; calyx-tube obconical, glabrescent, very shallowly cleft anteriorly, 5-dentate, the teeth lanceolate, the posterior smaller, entire to shallowly serrate, the others pinnatifid; corolla rose, the tube slender, long, 4-5 times as long as the calyx, hairy externally; galea much dilated distally with two teeth on the lower margins near the apex, abruptly constricted into a somewhat slender, straight beak; lower lip 3-lobed, the middle lobe smaller, ciliate on the margins when young; filaments glabrous.

One species in Sikang and western Szechuan (Map 42).

The species *Pedicularis batangensis* when first described was included in the "Axillares." Prain subsequently recognized several series under the "Axillares." Bonati included *P. batangensis* in the series Longipedes in his two keys of the series (in Bull. Bot. Soc. France, 57, Mém. 18: 16, 1910, and in Notes Bot. Gard. Edinb., 13: 113, 1921), which was followed by Limpricht. In view of the fact that *P. batangensis* contrasts strikingly with other species of the Longipedes, which as currently interpreted is a varied group of uncertain limitation, it is necessary to establish a separate series for its accommodation.

This series is sharply characterized by its nearly all opposite and much dissected leaves, scattered axillary flowers, long slender and hairy corolla-tubes, and the presence of a distinct beak together with teeth on the galea.

259. Pedicularis batangensis Bureau & Franchet Plate 14, fig. 213.

Pedicularis batangensis Bur. & Franch., in Morot. Journ. de Bot., 5: 106, 1891; Bonati, in Bull. Herb. Boiss. II, 7: 544, 1907; in Bull. Soc. Bot. France, 54: 184, 1907; Limpricht, in Repert. Sp. Nov., Beih. 12: 484, 1922; in Repert. Sp. Nov., 20: 256, 1924; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 209, 1934. The type, "Province de Se-tchuen, entre Batang et Litang [pendant le voyage de M. Bonvalet et du Prince Henri D'Orléans en 1890]," has not been seen.

The type locality is in Sikang Province.

On mountain slopes at an altitude of about 2700 meters, in Sikang and northwestern Szechuan. Flowers rose. Flowering from June through August.

SZECHUAN: Mow District, *Fang* 1510 (GH, NYBG, USNH).

SIKANG: Ta-tsien-lou, *Soulié* 978 (ANSP), *Cunningham* 139 (RBGE); Tongolo, *Soulié* 289 (ANSP), 2871 (NYBG); Kanting, *Chiao* 1802 (AA); Baurong to Tatsienlu, via Hadjaha, *Stevens* 305 (CM), 306 (CM).

A very distinct species characterized by its long slender tubular corolla with a much enlarged galea abruptly narrowed into a beak and with two distinct teeth on the lower margins of the galea. The corolla-tube is hairy externally. The capsules, found only on the Gray Herbarium sheet of *Fang* 1510, are very short, compressed-ovoid, obliquely truncate and acute at apex, about 8 mm. long and 6 mm. broad.

The leaves of *P. batangensis* are opposite, very rarely subopposite, and resemble those of *P. axillaris* but the segments are more linear and remote. In the leaf and fruit characters the species apparently approaches most nearly *P. axillaris*, but its unique flowers make its segregation into a distinct series highly desirable.

SECTION XXII. SCHIZOCALYX

Stems usually short, rarely long, branching or simple, erect or spreading; leaves long-petiolate, radical or cauline, the cauline alternate, sometimes opposite or subopposite, pinnatisect, rarely pinnatifid; flowers axillary, long- or short-pedicellate, scattered; calyx cleft anteriorly, 2-3, rarely 5-dentate; corolla with short or long and slender tube; galea extended into a long slender beak, sometimes twisted; lower lip with subequal or unequal lobes.

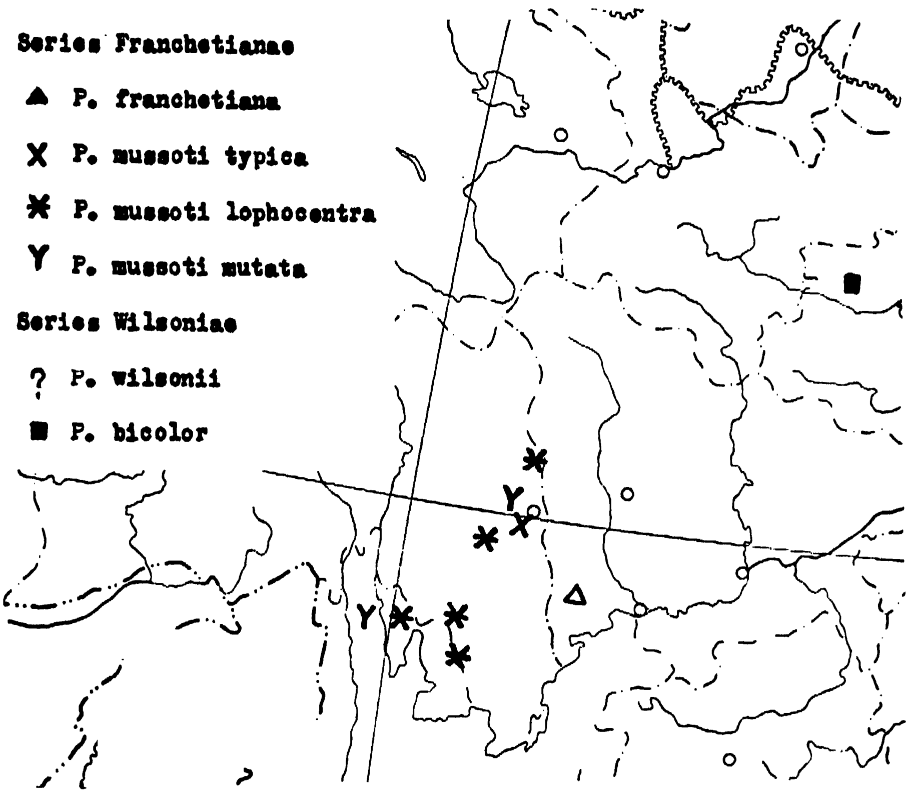
This section is characterized by the relatively short stem, the strongly cleft, usually 2-3-dentate calyx, and the beaked corolla. The range of the section is from the western Himalayas to western China, northern China, Mongolia and Siberia.

Series 77. Franchetianae

Franchetianae Prain, in Ann. Bot. Gard. Calcutta, 3: 70, 1890.

Low plants; stems several, branching or simple, slender; leaves cauline and radical, long-petiolate, oblong to linear-oblong, pinnatisect, the segments oblong, broadened at base, pinnatifid, the cauline leaves alternate, the lower sometimes opposite to subopposite; flowers scattered, axillary, very long-pedicellate, the pedicels to 3-4 or more times as long as the flowers, slender, erect and often flexuous; calyx ovoid, villose externally, membranaceous, deeply cleft anteriorly, reticulate, 2-3 or rarely 5-dentate, the posterior tooth small, subentire to serrate, the others flabellate, deeply incised-dentate to lobed; corolla purple, the tube short, scarcely exceeding the calyx in length, pubescent externally, enlarged distally, the galea falcate, cristate in front or not, projected into a long, slender, strongly curved or bending beak, the lower lip slightly longer than the upper, very broad, 3-lobed, the lobes rounded, subequal, the margins ciliate; stamens inserted near the middle of the tube, 2 or all 4 filaments hairy; stigmas scarcely exserted.

About 2 species in northwestern Yunnan and Sikang (Map 43).



Map 43.—Distribution of the series Franchetianae and Wilsoniae.

The series Franchetianae was originally considered by Prain as having strictly opposite leaves, and was associated by him with the Integrifoliae and Gyrorrhynchae to which it is not closely related. The scattered axillary long-pedicellate flowers clearly indicate that its relationship is with the series Longipedes.

Key to the Species

A. Stems branching; calyx-teeth 2, trifid and incised-dentate; beak pendant, parallel to the calyx, curved at the tip; 2 of the staminal filaments villose. 260. *P. franchetiana*

AA. Stems simple; calyx-teeth 3, rarely 5, the lateral teeth incised-dentate, the posterior tooth much smaller, subentire or dentate; beak curved to almost a circle; all 4 filaments hairy, the posterior ones sparsely so. .... 261. *P. mussoti*

260. Pedicularis franchetiana Maximowicz

Pedicularis franchetiana Maxim., in Bull. Acad. St. Pétersb., 32: 553, fig. 40, 1888; in Mél. Biol., 12: 823, fig. 40, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 209, 1890; Diels, in Bot. Jahrb., 29: 571, 1900; Limpricht in Repert. Sp. Nov., 20: 264, 1924. The type, "Szetchuan occidentali, regione Mou-pine (David! in hb. Paris., *P. siphonantha* admixta," has not been seen.

In southwestern Szechuan. Flowers purple. Known from the original collection only. No specimen seen.

This species, although several times referred to by various authors, is as yet known only from a single collection, and it has not been clearly understood by later authors. Maximowicz originally placed it in the Axillares, together with *P. longipes* and *P. axillaris*. These latter two are not strictly opposite-leaved species. Thus although *P. franchetiana* was originally described as opposite-leaved, most probably its leaves varied from opposite to subopposite and alternate as in the other two species just mentioned.

Prain made *P. franchetiana* into a series and placed it in his system with *P. integrifolia* Hook. f. and *P. gyrorrhyncha* as belonging to the Subsection Oppositifoliae of the Section Siphonanthae under the Division Longirostres. To these two species it is not at all closely related and Prain's arrangement in this respect seems very artificial. Nor is it in accord with Maximowicz's original concept. The arrangement of Prain was followed by Limpricht. Bonati (in Bull. Soc. Bot. France, 57, Mém. 18: 19, 1910) established the series Fallaces which contains long-tubular species like *P. wilsonii* and *P. bicolor* as well as short-tubular species like *P. franchetiana* and *P. mussoti.* While these long-tubular species should hardly be included together with short-tubular ones, Bonati's association of *P. franchetiana* with *P. mussoti* is apparently a correct interpretation of Maximowicz's concept of the present species.

Without access to actual specimens the real difference between *P. franchetiana* and *P. mussoti* can not be ascertained. Both have long-pedicellate axillary flowers, strongly cleft calyx and short-tubular corolla. The beak of *P. franchetiana,* as described and depicted by Maximowicz, is pendant, parallel to the calyx, more or less straight proximally and curved at the tip only. In *P. mussoti* the beak curves almost into a circle.

261. **Pedicularis mussoti** Franchet

Key to the Varieties

A. Calyx longer, to about 1 cm. long, the teeth 3, the posterior tooth small, the 2 lateral foliaceous, profoundly dentate.
  B. Galea not cristate in front. .... 261a. *P. m. typica*
  BB. Galea pronouncedly cristate in front, the appendage long-filiform and acuminate. .... 261b. *P. m. lophocentra*
AA. Calyx shorter, to about 5-7 mm. long, the teeth 5, the posterior small, the 4 lateral foliaceous and profoundly dentate. .... 261c. *P. m. mutata*

261a. **Pedicularis mussoti typica** Plate 14, fig. 214.

Pedicularis mussoti Franch., in Bull. Soc. Bot. France, 47: 24, 1900; Bonati, in Bull. Herb. Boiss., II, 5: 42, 1907; in Bull. Soc. Bot. France, 54: 183, 1907; Limpricht, in Repert. Sp. Nov., 20: 254, 1924. The types were all from Sikang: "Su-tchuen, environs de Ta-tsien-lou (Soulié, nos. 81, 234, 283; Mussot, nos. 276, 284, 286, 291)." They have not been seen. Among the cited specimens, *Soulié* 234 contains examples with 5 calyx-teeth and was designated by Bonati as the type of his var. *mutata.*

Eastern Sikang and northwestern Yunnan. Flowers purple.

YUNNAN: no precise locality, *Yü* 13040 (AA).

In this species, including its varieties, the cauline leaves are alternate, but often, especially the lower ones, become opposite or subopposite. The leaves also appear to be variable in size. This species is readily recognized by its low habit, axillary flowers with long pedicels, strongly cleft calyx, short corolla-tube and long slender beak.

261b. Pedicularis mussoti lophocentra (Handel-Mazzetti) comb. nov.

Pedicularis lophocentra Hand.-Maz., in Anz. Akad. Wiss. Wien, Math.-Nat. Kl., 59: 251, 1922; Symb. Sin., 7: 866, 1936; Limpricht, in Repert. Sp. Nov., 20: 251, 1924. The type, *Handel-Mazzetti* 7144, was from Sikang close to the Yunnan border: "Prov. Set-schwan austro-occ.: In jugi Santente supra monasterium Muli ad sept. pagi Yünnanensis Yungning regionis alpinae glarea calcea profunda, 4300–4400 *m*, legi 30 VII. 1915 (Nr. 7144) et versus Dschungdien in monte Gonschiga, 4500 *m*." An isotype from the Bonati Herbarium passes to University of California at Los Angeles.

Alpine meadows at altitudes of 3660 to 4900 meters in eastern to southeastern Sikang. Flowers rose to purple. Flowering in July and August.

SIKANG: Muli, *Handel-Mazzetti* 7144 (UCLA), *Ward* 4735 (RBGE); Mount Konka, Risonquemba, Konkaling, *Rock* 16809 (ANSP, USNH), 16865 (ANSP, USNH); Liengho-kou, *Wang & Wen* 609 (AA), 652 (AA); Litang-Yalung divide, *Ward* 4476 (RBGE); Glacier Lake, *Ward* 4687 (RBGE).

A remarkable plant with a readily recognized long filiform and acuminate appendage in front of the galea. Handel-Mazzetti originally noted its relationship with *P. franchetiana* and later (l.c., 1936) placed his species in the series Longipedes but noted that it is aberrant in that series. In all characters except the appendage it agrees closely with the typical form of *P. mussoti*. This form of pointed-cristate galea is observed in several other species and in each case the cristate form is recognizable as a variety of the species. The relationship of *P. mussoti* to its var. *lophocentra* is just the same as *P. cranolopha* to *P. c. longicornuta* Prain (*P. birostris* Bur. & Franch.) and *P. siphonantha* D. Don to *P. s. birmanica* Bonati. This clearly illustrates that parallel but independent lines of evolution occur in the development of this accessory organ.

261c. Pedicularis mussoti mutata Bonati

Pedicularis mussoti Franch. var. *mutata* Bonati, in Bull. Soc. Bot. France, 54: 375, 1907; Limpricht, in Repert. Sp. Nov., 20: 254, 1924. The type, "Ta-Tsien-Lou, sur le calcaire, n° 234 bis, 1892, *Soulié*," has not been seen. This number was originally included among the specimens cited by Franchet for the species.

In eastern Sikang and northwestern Yunnan. Flowers purple.

YUNNAN: no precise locality, *Yü* 12817 (AA).

The specimen cited above is a poor one with only young flowers, but it agrees well with the essential characters of this variety. The latter differs from the type chiefly in the shorter, 5-dentate, instead of 3-dentate calyx. It also has longer stems, smaller leaves, smaller flowers, and longer beak.

Series 78. Wilsoniae ser. nov.

Fallaces Bonati, in Bull. Soc. Bot. France, 57, Mém. 18: 19, 1910, p.p.

Plants low, caespitose, with short stems or subacaulescent, the stems erect or spreading-ascending, pubescent; leaves nearly all radical, long-petiolate, the cauline alternate or opposite, smaller, the blades elliptic to oblong-ovate, shallowly crenately lobed to deeply pinnatifid; flowers axillary, few, pedicellate, the pedicels erect; calyx campanulate to cylindric, cleft anteriorly, with 2 or 3 teeth, the teeth equal to unequal, the posterior small, entire to hardly crenate, the lateral foliaceous, stipitate, serrate; corolla reddish throughout or purplish with yellowish lower lip, the tube broad, cylindric, about 2-2½ times as long as the calyx, glabrous or sparsely hairy externally, enlarged distally; galea erect proximally, bending near the middle, prolonged into a cylindric beak, the beak 2-5 mm. long, straight or sigmoid, the apex entire; lower lip large and broad, longer than the upper, 3-lobed, the lobes unequal, the middle lobe much smaller and not distad, the margins very finely ciliate or glabrous; staminal filaments glabrous or hairy.

Two species in southern Shensi and western Hupeh (?) (Map 43).

Bonati's Fallaces originally contained both short-tubular species like *P. franchetiana* and *P. mussoti* as well as long-tubular ones like *P. bicolor* and *P. wilsonii.* The first two are here recognized as the ones forming the series Franchetianae, leaving the last two forming the Wilsoniae. *P. wilsonii* and *P. mussoti* were included in the series Musicocolae by Limpricht (in Repert. Sp. Nov., 20: 254, 1924) which is evidently inadequate. *P. bicolor* was placed by him first in the Longiflorae (l.c., 250) but later (in op. cit., 23: 338, 1927) he mentioned Bonati's idea that it should be associated with *P. wilsonii.*

This series is somewhat intermediate in the floral characters between the Franchetianae and the Longiflorae. Compared with the Franchetianae it is more highly specialized in the long corolla-tube. But the length of the corolla-tube when compared with that of the Longiflorae is relatively short. Moreover, the tube enlarges distally instead of being cylindric throughout like that of the Longiflorae.

Key to the Species

A. Leaves deeply pinnatifid; calyx with 3 teeth; corolla reddish throughout, the beak 2-4 mm. long, straight; filaments all glabrous. .... 262. *P. wilsonii*

AA. Leaves shallowly crenately lobed; calyx with 2 teeth; corolla with purple galea and yellowish lower lip, the beak 4-5 mm. long, sigmoid; filaments hairy. 263. *P. bicolor*

262. Pedicularis wilsonii Bonati

Pedicularis wilsonii Bonati, in Bull. Soc. Bot. France, 54: 184, 376, 1907; Gen. Pedicularis pl. [front.], 1918; Limpricht, in Repert. Sp. Nov., 20: 254, 1924. The type, "[Wilson] n° 4238 (en partie seulement) [recueillie en 1904, dans le centre de la Chine]," is in the Paris Museum. It has not been seen. The locality of the species is possibly Hupeh, as indicated by Bonati (Gen. Pedicul. 75, 1918). However, Wilson's other numbers near to that of this collection pertain mostly to plants of Sikang. This same number as listed by Bonati contains also elements representing *P. mussoti*. As the latter species is from Tatsienlu (Kanting) of Sikang Province, it is probable that the type locality of *P. wilsonii* is the same.

In western Hupeh (?). Flowers red. Known from the original collection only. No specimen seen.

A low plant with short stems and long corolla-tube which is dilated above. The calyx resembles that of *P. mussoti* but otherwise the plant is very different from the latter, especially in the long tube, the shorter pedicels, the glabrous filaments, and also in the habit.

263. Pedicularis bicolor Diels Plate 14, fig. 215.

Pedicularis bicolor Diels, in Bot. Jahrb., 29: 570, 1900; Limpricht, in Repert. Sp. Nov., 20: 250, 1924; 23: 338, 1927. The type was from Shensi: "Gipfel des Kuan tou shan, Gi[raldi] 1795,—fl. Jul.!." A flower from the type is in the Bonati Herbarium, from which it passes to the University of California at Los Angeles.

Shensi. Flowers purple and yellow. Flowering in July.

SHENSI: Kuan tou shan, *Giraldi* 1795 (UCLA); Mt. Kian-San, *Giraldi* s.n. (ANSP, UCLA).

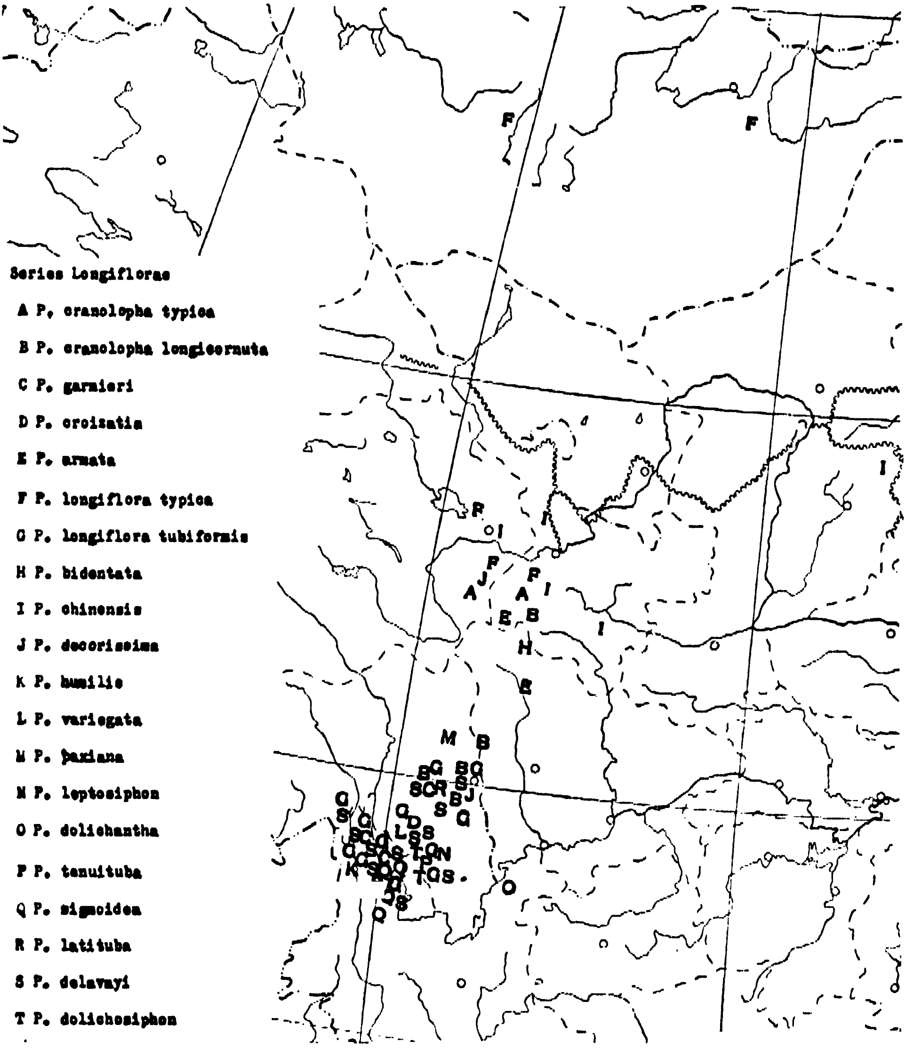
A relatively low plant with elliptic and shallowly crenately lobed leaves. The corolla-tube in mature flowers is twice as long as the calyx and enlarges distally. Diels described the filaments as villose, but in the specimens examined only the anterior ones are villose, the posterior being glabrous.

Series 79. Longiflorae

Longiflorae Prain, in Ann. Bot. Gard. Calcutta, 3: 67, 1890.

Low or tall plants, acaulescent to caulescent, the stems erect or sometimes spreading; leaves radical or cauline, more or less similar, the cauline alternate to sometimes opposite or subopposite, long-petiolate, the blades usually linear-oblong, deeply pinnatifid to pinnatisect, the segments usually ovate and serrate; flowers subsessile or short- to rarely long-pedicellate, the lower axillary and scattered, the upper more numerous and compact; bracts similar to the leaves; calyx campanulate to cylindric, slightly or not reticulate, cleft anteriorly, 2-3-, rarely 5-dentate, the posterior tooth often smaller, entire to serrate, the lateral teeth large, pinnatisect to serrate; corolla yellow, white or purple, long and slender-tubular, the tube erect, 3-4 times or more as long as the calyx, pubescent to glabrate, not enlarged distally; galea falcate, erect or twisted, often glandular dorsally, often slightly or conspicuously cristate, sometimes non-cristate, the apex prolonged into a long slender beak, the beak curved or sigmoid, entire or bilobed at tip; lower lip profoundly 3-lobed, the lobes equal to subequal, rounded to emarginate or bilobed, the margins finely ciliate; stamens inserted at or near the apex of the tube, the filaments glabrous or hairy; styles included or the stigmas exserted.

About 20 species from the western Himalayas to northern Yunnan, Chahar, Mongolia, and Siberia (Map 44).



Map 44.—Distribution of the series Longiflorae.

The series Longiflorae has the most highly modified flowers in the genus. Specialization in the flowers includes the strongly cleft calyx with its reduced number of teeth, the extremely long and slender corolla-tube, and the long, slender, curved or sigmoid beak. The galea has a tendency to curve or twist toward one side. The lower lip has deeply cut lobes, these sometimes further specialized by either secondary lobing or by reduction in size. Thus all culminating conditions in the various lines of evolution in the calyx and corolla are synthesized in the flowers of the Longiflorae.

Key to the Species

A. Corolla yellow, the galea not twisted.

  B. Galea crested in front; corolla-tube about 2 mm. wide and 3 or less times as long as the calyx; calyx-teeth 3, the posterior lanceolate, small, the lateral very large, ovate, deeply pinnatifid.

    C. Corolla-tube about 4 cm. or more long; lobes of the lower lip rounded; pedicels shorter, hardly 6-7 mm. long.

      D. Corolla yellow throughout, smaller, the lower lip about 2.5 cm. broad; galea more prominently crested; calyx more membranaceous, less hairy and reticulate distally. .... 264. *P. cranolopha*

      DD. Corolla yellow with the lower lip reddish and with white margins, larger in size, the lower lip about 3 cm. wide; galea less prominently crested; calyx more densely hairy, not reticulate. 265. *P. garnieri*

    CC. Corolla-tube shorter, about 2.5-3 cm. long; lateral lobes of the lower lip more or less emarginate; pedicels longer, about 10-15 mm. long. 266. *P. croizatiana*

  BB. Galea not crested in front; corolla-tube more slender, about 1.5 mm. or less wide, 4-10 times as long as the calyx; calyx-teeth usually 2, usually as long as broad to rarely elliptic, incised-dentate to subtrilobed.

    C. Galea bending rectangularly near the middle, the beak pointing forward, sigmoid. .... 267. *P. armata*

    CC. Galea curving gradually, the beak simply curved or nearly straight, forming, together with the galea, a semicircle or a circle.

      D. All 3 lobes of the lower corolla-lip emarginate; beak bifid at tip; leaves pinnatifid, the lobes oblong, obtuse. ..... 268. *P. longiflora*

      DD. Lateral lobes of the lower corolla-lip rounded, not emarginate; beak entire at tip; leaves crenately lobed, the lobes rounded to subrounded.

        E. Calyx-teeth elliptic, incised-serrate; galea curving downward into a nearly straight beak, the entire galea being shaped like a horseshoe; middle lobe of the lower lip rounded, about ⅓ as large as the lateral lobes. .... 269. *P. bidentata*

        EE. Calyx-teeth subreniform, subtrilobed, deeply incised-dentate; galea slightly bending distally, forming nearly a circle with the strongly curved beak; middle lobe of the lower lip emarginate, about ½ as large as the lateral ones. 270. *P. chinensis*

AA. Corolla purple, or white with purple galea or wholly white, but never yellow, galea slightly to usually strongly twisted to one side.

  B. Leaves pinnatifid; calyx-teeth shallowly pinnatifid; flowers relatively large; corolla-tube 10-12 cm. long and 2 mm. wide; galea slightly twisted, very densely pubescent in the middle, very prominently cristate in front; beak curving below, the galea forming almost a circle, the apex prolonged into a club-shaped structure on the dorsal side. .... 271. *P. decorissima*

  BB. Leaves pinnatisect to deeply pinnatifid; calyx-teeth deeply pinnatifid to palmatifid; corolla-tube 2.5-8 cm. long, 1-1.5 cm. to rarely 2 mm. wide; galea very strongly twisted to one side, not cristate or inconspicuously so, glabrous or sparsely glandular-hairy; beak curved or sigmoid, turning upward above the galea, the tip entire or bifid.

    C. Dwarf plants with short creeping stem; calyx glabrous, short (5-6 mm.), the teeth 2, deeply trilobed; corolla-tube about 1-2.5 cm. long. 272. ***P. humilis***

    CC. Tall or low plants, acaulescent or with erect stems; calyx pubescent, longer (1 cm. or more long), the teeth 2-5, deeply pinnatifid to palmatifid; corolla-tube 3.5 cm. or more long.

D. Middle lobe of the lower corolla-lip entire, truncate or rounded, not bilobed; anterior staminal filaments sparsely hairy distally, the posterior ones glabrous.

  E. Corolla white with purple galea, the middle lobe of the lower lip ⅓ as large as the lateral lobes or even smaller; calyx campanulate, enlarged distally. .... 273. *P. variegata*

  EE. Corolla of one color, either white or purple throughout, the middle lobe of the lower lip as large as the lateral lobes; calyx cylindric, not enlarged distally.

    F. Corola white; lobes of the lower lip more or less rounded.

      G. Calyx-teeth 2; corolla-tube 9-10 times as long as the calyx. .... 274. *P. paxiana*

      GG. Calyx-teeth 3-5; corolla-tube 6-7 times as long as the calyx. .... 275. *P. leptosiphon*

    FF. Corolla purple; middle lobe of the lower lip truncate.

      G. Corolla-tube about 6 cm. long, pubescent; calyx chartaceous, densely hairy, the teeth 2. 276. *P. dolichantha*

      GG. Corolla-tube about 8-11 cm. long, nearly glabrous to sparsely pubescent; calyx membranaceous, the teeth 3, the posterior smaller. .. 277. *P. tenuituba*

DD. Middle lobe of the lower corolla-lip deeply or shallowly bilobed; anterior staminal filaments or all filaments densely hairy distally.

  E. Corolla-tube more or less densely hairy; middle lobe of the lower corolla-lip shallowly bilobed; all 4 staminal filaments hairy distally.

    F. Plant tall, the stem about 2-3 dm. tall; flowers very numerous; calyx sparsely reticulate distally; corolla-tube about 1 mm. wide; beak strongly sigmoid, 1-2 cm. long. .... 278. *P. sigmoidea*

    FF. Plant low, the stem about 4-5 cm. tall; flowers axillary, not numerous; calyx not reticulate; corolla-tube about 2 mm. wide; beak falciform, 2-3 mm. wide. 279. *P. latituba*

  EE. Corolla-tube glabrous to sparsely hairy; middle lobe of the lower corolla-lip usually deeply bilobed; 2 of the staminal filaments hairy distally.

    F. Petioles and stems glabrous to sparsely pubescent; leaf-segments serrate, not cartilaginous; calyx-tube about 8-10 mm. long, the teeth 2-5, short-stipitate; lower lip of corolla about 1.5 cm. wide; the middle lobe deeply bilobed. .... 280. *P. delavayi*

    FF Petioles and stems densely long-villose; leaf-segments cartilaginous-serrate on the margins; calyx-tube about 6-7 mm. long, the teeth 3, long- and slender-stipitate; lower lip of corolla about 1.8 cm. wide, the middle lobe distinctly but less deeply bilobed. 281. *P. dolichosiphon*

Status uncertain. .... 282. *P. fastigiata*

264. Pedicularis cranolopha Maximowicz

Key to the Varieties

A. Crest on the galea short, the apex acute. .... 264a. *P. c. typica*

AA. Crest on the galea modified into a long slender and attenuate process. 264b. *P. c. longicornuta*

264a. Pedicularis cranolopha typica Plate 14, fig. 216.

Pedicularis cranolopha Maxim., in Bull. Acad. St. Pétersb., 24: 55, 1878; 32: 533, fig. 10, 1888; in Mél. Biol., 10: 85, 1878; 12: 795, fig. 10, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 207, 1890; Limpricht, in Repert. Sp. Nov., 20: 249, 1924; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 33, 1933; Pai, in Contr. Inst. Bot. Nat. Peiping, 2: 210, 1934, p.p.[17] The type, "In Chinae prov. Kansu, confinibus australibus jugi fl. Tetung comitantis, nec non, ex collectore, circa templum Tschöibsen (Przewalski)," has not been seen.

Pedicularis cranolopha Maxim. var. *typica* Prain, in Hook., Icon. Plant., 23: pl. 2208A, 1894.

Alpine meadows at an altitude of about 3800 meters in northeastern Chinghai and western Kansu. Flowers yellow. Flowering in June.

CHINGHAI: Radja and Yellow River gorges, mountains southwest of Radja, *Rock* 14186 (ANSP, GH, NY, USNH).

This species is related to *P. longiflora* and its variety. However, it is readily distinguished by its crested galea which in the var. *longicornuta* is considerably elongated into a prominent, pointed process. From *P. garnieri* it is distinguished by its smaller flowers and prominent galea, as well as its calyx being more membranaceous, less hairy, and reticulate distally. In *P. cranolopha* also the lower corolla-lip is very finely ciliate on the margins, and the middle lobe is emarginate.

264b. Pedicularis cranolopha longicornuta Prain

Pedicularis birostris Bur. & Franch., in Morot, Journ. de Bot., 5: 107, 1891; Bonati, in Bull. Herb. Boiss. II, 7: 541, 1907; in Bull. Soc. Bot. France, 54: 183, 1907; Limpricht, in Repert. Sp. Nov., Beih. 12: 483, 1902; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 209, 1934. The type, "Province de Se-tchuen a Ta-tsien-lou [recueillie pendant le voyage de Bonvalot et du Prince Henri d'Orléans en 1890]," has not been seen. This synonymy was first given by Prain. From the original description and specimens identified by Bonati, there is no doubt about the identity of this species with *P. c. longicornuta* Prain.

Pedicularis cranolopha Maxim. var. *longicornuta* Prain, in Hook., Icon. Plant., 23: pl. 2208B, 1894; Limpricht, in Repert. Sp. Nov., 20: 249, 1924; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 33, 1933. The type, " prov. Szechuan, *Pratt* (No. 167)," has not been seen. It was probably taken near the Tatsienlu (Kanting) region, now in eastern Sikang Province.

Alpine meadows at altitudes of 2600 to 4150 meters in southwestern Kansu and eastern Sikang. Flowers yellow. Flowering in July and August.

KANSU: T'ao River basin, northwest of Choni, *Rock* 12928 (ANSP, GH, NYBG).

SIKANG: Tatsienlu, *Soulié* 557 (ANSP, UCLA); Tongolo, *Soulié* 2850 (ANSP, UCLA); north of Chiu-lung-hsien, in Minya country, southwest of Tatsienlu, *Rock* 17467 (ANSP, USNH); Lien-ho-kou, *Wang & Wen* 614 (AA); Kanting, *Chiao* 1823 (AA); Baurong to Tatsienlu, via Hadjaha, *Stevens* 308 (CM).

Prain is apparently correct in treating this as a variety of *P. cranolopha* instead of as a separate species. Besides the crest being modified into a long, slender and pointed process there is no notable difference between this and *P. cranolopha*. Similar modification in the crest on the galea is found in *P. mussoti* Franch. var. *lophocentra* (Hand.-Maz.) and *P. siphonantha*

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[17] Pai recorded also *Fang* 4420, which is *P. armata* Maxim.

D. Don var. *birmanica* Bonati. In each case the presence of this long crest is the only character distinguishing the varieties from the typical forms of the species.

265. Pedicularis garnieri Bonati Plate 14, fig. 217.

Pedicularis garnieri Bonati, in Bull. Soc. Bot. France, 55: 243, 1908. Bonati's type was from Sikang: " Yargong (R. Soulié), n° 3763, Juillet 1904." It has not been seen.

Pedicularis cranolopha Maxim. var. *garnieri* Bonati, in Notes Bot. Gard. Edinb., 13: 144, 1921; Limpricht, in Repert. Sp. Nov., 20: 250, 1924. This combination was made by Bonati himself very obscurely in a list of determinations and was without any indication as to its being a new combination. He there cited *Forrest* 13187. However in his key of the series Longiflorae on page 108 of the same article he retained the specific name *P. garnieri* Bonati in equal standing with *P. cranolopha* Maxim. *Forrest* 13187 agrees well with his original description in general. Unless this specimen actually represents a different plant from his original description, *P. tricolor* Hand.-Maz. is undoubtedly identical and synonymous.

Pedicularis tricolor Hand.-Maz., in Anz. Akad. Wiss. Wien, Math.-Nat. Kl., 59: 250, 1922; Symb. Sin., 7: 864, 1936; Limpricht, in Repert. Sp. Nov., 20: 250, 1924. Handel-Mazzetti's type was from: "Prov. Yünnan bor.-occ.: In pascuis siccis temperatis prope pagum Dschungdien usque ad vicum Baoschi copiose, s[olo] arenaceo et calceo, ca. 3400-3600 *m*, legi 17. VIII, 1915 (Nr. 7526)." An isotype in the Bonati Herbarium will pass to the University of California at Los Angeles. Handel-Mazzetti described the filaments as glabrous, but the specimen shows that the two anterior filaments are densely hairy distally and the posterior ones are sparsely so to nearly glabrous. This type specimen agrees exactly with *Forrest* 13187 which Bonati identified as representing his own *P. garnieri*, and they were also from the same locality.

Alpine meadows at altitudes of 3000 to 3600 meters in northwestern Yunnan and eastern Sikang. Flowers bright yellow with the lips reddish and with whitish margins. Flowering in August and September.

YUNNAN: Bei-ma-shan, Mekong-Yangtze divide, *Forrest* 13187 (ANSP, UCLA); Chungtien, *Handel-Mazzetti* 7526 (UCLA), *Feng* 1952 (AA), *Yü* 13678 (AA), no precise localities, *Yü* 12769 (AA), 12947 (AA), *Forrest* 28882 (ANSP), 30812 (ANSP).

This species is well characterized by its large flowers which are yellowish but with reddish lips which are whitish on their margins. The calyx is ovoid and very broad with 2 large, ovate, pinnatisect teeth and a small, lanceolate, slightly serrate posterior one. The filaments are all hairy, the posterior ones being sparsely so. This species is apparently closely related to *P. cranolopha* but differs in larger corolla, broader and more densely villose calyx and reddish lower lip which is about 3 cm. broad.

266. Pedicularis croizatiana sp. nov. Plate 14, fig. 218.

Planta perennis, nana, vix 1.5 dm. alta; radicibus singulis, filiformibus, valde elongatis, simplicibus, pubescentibus, foliatis; foliis radicalibus vel caulinis, similibus, petiolatis, caulinis alternis vel interdum subоppositis, petiolis 1-1.5 cm. longis, leviter alatis, pubescentibus; laminis membranaceis, glabris vel sparse pubescentibus, linearibus vel lineari-ovatis, circiter 2-4.5 cm. longis, 5-10 mm. latis, acutis, profunde pinnatisectis, lobis oblongis, utrinsecus 9-12, remotis, circiter 3 mm. longis, obtusis, serrulatis; floribus superioribus compactis, racemosis, circiter 2-3 cm. longis, floribus inferioribus valde remotis laxis, axillaribus; bracteis foliosis, calycem subaequantibus, pinnatifidis, petiolis plerumque dilatatis; pedicellis 1-1.5 cm. longis, sparse pubescentibus; calyce cylindrico, circiter 1 cm. longo, membranaceo, vix reticulato, externe sparse villoso, antice fisso, prominente 3-dentato, dentibus inaequalibus, lateralibus circiter 1 cm. longis, dente posteriore ⅓-plo minore, dentibus basi constrictis, superne acutis valde pinnatifidis, lobis serrulatis, corollā luteā, circiter 4 cm. longā: tubo longo, erecto, circiter 3 cm. longo 2 mm. lato, externe sparse pubescente, superne vix ampliato; galeā falcatā, ad apicem curvatā, parte verticali ciricter 7 mm. longā, parte horizontali circiter 4 cm. longā, in rostrum longum productā, fronte prominente lateque cristatā, rostro cylindrico, circiter 5 mm. longo, breviter incurvato, apice integro; labio inferiore prominente, circiter 2.5 cm. lato, 3-lobato, lobis subaequalibus, subemarginatis, margine subtiliter ciliatis; staminibus ad apicem tubi insertis, filamentis ad apicem omnibus villosis; stylo leviter exserto; capsulis ignotis.

In pine forests at an altitude of 3700 meters, mountains between the Litang and Shou-Chu Rivers, between Wa-Erh-Dje and Garu, Muli territory, Sikang Province, collected in flower, July-August 1928, by J. F. Rock, No. 16899; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotype in the United States Herbarium. Flowers pale yellow. Only collection seen.

This species is related to *P. cranolopha* Maxim. and *P. garnieri* Bonati, differing notably in the longer pedicels, the shorter corolla-tube and the more or less emarginate lateral lobes of the lower corolla-lip.

This species is named in honor of Dr. Leon Croizat, linguist and specialist on the Euphorbiaceae, of the Arnold Arboretum of Harvard University.

267. Pedicularis armata Maximowicz Plate 14, fig. 219.

Pedicularis armata Maxim., in Bull. Acad. St. Pétersb., 24: 56, 1878; 32: 533, fig. 9, 1888; in Mél. Biol., 10: 86, 1878; 12: 749, fig. 9, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 205, 1890; Limpricht, in Repert. Sp. Nov., 20: 249, 1924; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 32, 1933, p.p.[18] The type, "In Chinae prov. Kansu, in pratis ejusdem jugi frequens (Przewalski)," has not been seen.

"*Pedicularis cranolopha*" *sensu* Pai, in Contr. Inst. Bot. Nat. Akad. Peiping, 2: 210, 1934, p.p.; *non* Maxim. Identification based on *Fang* 4420.

Alpine meadows at an altitude of about 3660 meters in southwestern Kansu and northern Szechuan. Flowers yellow. Flowering in August.

KANSU: Upper Tebbu country, from Kwang Kei pass to Tebbu country, *Rock* 13091 (ANSP, CM, GH, NYBG, UC).

SZECHUAN: Sung-pan District, *Fang* 4108 (ANSP, GH, NYBG, USNH), 4420 (ANSP, GH, USNH).

This species is restricted in its distribution to southwestern Kansu and northern Szechuan. Plants from other localities credited to it by some authors apparently belong to other related species. From the allied species with yellow flowers this is readily distinguished by its galea being bent rectangularly in the middle, its beak extending forward, long, slender and sigmoid. In other species the galea curves gradually distally and together with the beak which points downward and is simply curved and not sigmoid, forms a semicircle to almost a circle.

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[18] *Rock* 12880 and 13148 cited by Rehder & Kobuski, various collections from Hsiao-wu-tai Shan cited by Pai, and also *Ching* 460 cited by Walker, in Contr. U. S. Nat. Herb., 28: 659, 1941, are *P. chinensis* Maxim.

268. **Pedicularis longiflora** Rudolph

This comprehensive species covers a wide area from Dahuria southwestward to Yunnan and then west to Baltistan. The typical form occurs in the north, from Dahuria to Hopei and Kansu in northern China. A southern plant extends from Sikang to Yunnan and throughout the Himalayas. These two, formerly collectively placed in the species by various authors, are recognized as two subspecies by Pennell (in Monogr. Acad. Nat. Sci. Phila., 5: 149-150, 1943). *P. tubiflora* Fisch. (in Mem. Soc. Nat. Moscou, 3: 58, 1812) is a synonym of the typical form of the species.

Key to the Subspecies

A. Calyx-teeth longer (2-3 mm.) and more deeply cut; lower lip of corolla wider (15-20 mm.) with a narrow maroon stripe on each antero-lateral ridge of palate or without such a stripe. .... 268a. *P. l. typica*

AA. Calyx-teeth smaller (1-2 mm., rarely 3 mm.) and less deeply cut; lower lip of corolla narrower (13-15 mm.), usually with a wide maroon stripe covering each antero-lateral ridge of the palate. .... 286b. *P. l. tubiformis*

268a. **Pedicularis longiflora** typica Plate 15, fig. *220*.

Pedicularis longiflora Rudolph, in Mém. Acad. St. Pétersb., 4: 345, pl. 3, 1811; Maxim., in Bull. Acad. St. Pétersb., 24: 56, 1878; 32: 534, 1888; in Mél. Biol., 10: 86, 1878; 12: 796, 1888; Franch., in Morot, Journ. de Bot., 4: 317, 1890; Limpricht, in Repert. Sp. Nov., 20: 250, 1924, p.p.; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 33, 1933; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 214, 1934. The type was from Siberia: "Habitat, teste cl. Adams, comite peregrinatoris nostri per plures regiones, ad lacum Baicalensem."

"*Pedicularis chinensis*" *sensu* Maxim., in Bull. Acad. St. Pétersb., 32: 534, 1888, p.p.; in Mél. Biol., 12: 796, 1888, p.p.; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 33, 1933; *non* Maxim. 1878. *Potanin* s.n. cited by Maximowicz, and *Rock* 13101 and 13355 cited by Rehder & Kobuski are *P. longiflora typica*.

Alpine meadows or along streams at altitudes of 3350 to 3500 meters from the vicinity of Lake Baikal and Dahuria to northern China from Hopei to Kansu and Chinghai. Flowers yellow. Flowering from July to September.

MONGOLIA: valley of Bain-gol, *Klementz* s.n. (ANSP, UCLA); west of Kerulen River, *Ikonnikov-Galitzky* 1610 (NYBG); northern Mongolia, Khangai, *Ikonnikov-Galitzky* 536 (NYBG).

KANSU: Upper Tebbu country, Drjakana, opposite Lossungamba, *Rock* 13101 (ANSP, GH, NYBG).

CHINGHAI: along Lake Kokonor, *Farrer* s.n. (RBGE), *Rock* 13355 (ANSP, GH, NYBG); Ba Valley, Gancoche Village, *Rock* 14354 (ANSP, GH, NYBG).

268b. Pedicularis longiflora tubiformis (Klotzsch) Pennell

Pedicularis tubiformis Klotzsch, in Bot. Ergebn. Reise Waldemar, 106, pl. 57, 1862. The type "*Dr. Hoffmeister* sammelte diese Art in Himalaya [in 1846]," was from the Himalayas. Exact localities unknown, but his collections were made in the Himalayas from Garhwal to Bashahr.

"*Pedicularis longiflora*" *sensu* Bonati, in Bull. Herb. Boiss. II, 7: 541, 1907; in Notes Bot. Gard. Edinb., 5: 79, 1911; 7: 81, 1912; 15: 163, 1926; Limpricht, in Repert. Sp. Nov., 20: 250, 1924, p.p.; Marquand, in Journ. Linn. Soc. Bot., 48: 212, 1929; Hand.-Maz., Symb. Sin., 7: 864, 1936; *non* Rudolph. The Yunnan and Sikang plants referred to this species are not the typical form of Rudolph but are the southern subspecies.

"*Pedicularis chinensis*" *sensu* Bonati, in Bull. Soc. Bot. France, 54: 183, 1907; Limpricht, in Repert. Sp. Nov., 20: 250, 1924, p.p.; *non* Maxim. *Wilson* 4234 cited by these authors is *P. l. tubiformis*.

Alpine meadows and marshy moorland at altitudes of 2700 to 5300 meters throughout the Himalayas to northwestern Yunnan and Sikang. Flowers yellow, usually with two maroon areas covering the two ridges of the palate. Flowering from early May to October.

WESTERN CHINA: no precise locality, *Wilson* 4234 (UCLA).

SIKANG: Tongolo, *Soulié* 409 (UCLA); Tatsienlu, *Soulié* 776 (ANSP); Litang-Yalung divide, *Ward* 4462 (RBGE); Muli territory, mountains between the Litang and Yalung Rivers, between Muli Gomba and Baurong and Wa-Erh-Dje, *Rock* 16649 (ANSP, USNH); Muli territory, mountains between the Litang and Shou-Chu Rivers, between Wa-Erh-Dje and Garu, *Rock* 16781 (ANSP, USNH); Muli territory, mountains of Kulu, *Rock* 18099 (ANSP, USNH), 18206 (ANSP, USNH), 23947 (CM, MBG, NYBG, UC, UP, USNH); north of Chiu-lung-hsien, in Minya country, southwest of Tatsienlu, *Rock* 17738 (ANSP, USNH); Tsa-wa-rung, Hi-ma-la, *C. W. Wang* 65559 (AA); Shiangcheng, Delongwu, *Yü* 13291 (AA); Muli, Kulu, *Yü* 14245 (AA), 14324 (AA).

YUNNAN: no precise localities, *Forrest* s.n. (UCLA), 12699 (UCLA), 28844 (ANSP), 30512 (ANSP), 30810 (ANSP), *Yü* 7007 (AA), 7132 (AA), 12286 (AA), 12999 (AA); northeast of the Yangtze bend, *Forrest* 10558 (UC); Chung-tien Plateau, *Forrest* 10602 (UC); Salween-Kiukiang divide, *Forrest* 19923 (UCLA); Chungtien, *Schneider* 3346 (USNH); Mt. Pei-ma-shan, Mekong-Salween divide between Atuntze and Pungtzera, *Rock* 10006 (ANSP, UC, USNH); mountains of Ludu, northwest of Likiang, west of the Yangtze, *Rock* 18517 (ANSP, USNH); slopes of Mt. Gyi-na lo-ko, the second peak of the Yu-lung Shan, *Rock* 24991 (CM, MBG, UC, UP, USNH); Wei-si District, *Tsai* 59744 (AA); Chungtien, *Feng* 1575 (AA), 1943 (AA).

269. Pedicularis bidentata Maximowicz

Pedicularis bidentata Maxim., in Bull. Acad. St. Pétersb., 32: 533, fig. 11, 1888; in Mél. Biol., 12: 795, fig. 11, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 205, 1890; Limpricht, in Repert. Sp. Nov., 20: 249, 1924. The type, "Prov. Szetschuan: monte Kungála (Potanin, 1885, specc. 2)," has not been seen.

In northern Szechuan. Flowers yellow. Known from the original collection only. No specimen seen.

This species appears to be very near *P. chinensis* Maxim. It was described as a low plant with a very short stem, while *P. chinensis* is a fairly tall plant. The calyx-teeth are elliptic and incised-dentate. The lower lip with its rounded lobes of which the middle one is much the smallest, and with its densely ciliated margins, resembles that of *P. chinensis*. However, in *P. chinensis* the middle lobe is about ½ as large as the lateral ones and is truncate, while in *P. bidentata* it is only ⅓ as large as the lateral ones and is rounded. The galea of *P. bidentata* is about 7 mm. long, curving downward in a semicircle into a beak of equal length.

270. Pedicularis chinensis Maximowicz Plate 15, fig. 221.

Pedicularis chinensis Maxim., in Bull. Acad. St. Pétersb., 24: 57, 1878; 32: 534, 1888, p.p.; in Mél. Biol., 10: 87, 1878; 12: 796, 1888, p.p.;[19] Hance, in Journ. Bot. II, 7: 234, 1878; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 206, 1890; Diels ex Futterer, Durch Asien, 3: 20, 1901; Limpricht, in Repert. Sp. Nov., Beih. 12: 483, 1922; in Repert. Sp. Nov., 20: 250, 1924, p.p. The types, "In Chinae prov. Kansu (Przewalski, Piasezki) et Petschili, jugo Siao-wu-tai-shan (Hancock)," have not been seen. This species was not illustrated by Maximowicz in his extensive treatment of the genus in 1888. A later citation of Maximowicz (l.c., 1888), *Potanin* s.n. collected in 1885, is in the Bonati Herbarium, and will pass to the University of California at Los Angeles.

"*Pedicularis longiflora*" *sensu* Hance, in Journ. Bot. II, 7: 13, 1878; *non* Rudolph. Hance's identification was based on *Hancock* s.n., one of the syntypes of *P. chinensis* Maxim.

"*Pedicularis armata*" *sensu* Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 32, 1933, p.p.;; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 209, 1934, p.p.; Walker, in Contr. U. S. Nat. Herb., 28: 695, 1941; *non* Maxim. The specimens cited by these authors represent *P. chinensis* instead of *P. armata*. See footnote under the latter.

Pedicularis sp. Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 35, 1933. Based on *Rock* 12689.

Alpine meadows at altitudes of 1700 to 2900 meters, from northern Chinghai, southern and central Kansu eastward to southern Chahar. Flowers yellow. Flowering in July.

CHINGHAI: Sining, *Futterer* 36 (UCLA).

KANSU: Da-tung, *Farrer* 637 (RBGE); Lien-hoa-shan, *Rock* 12689 (ANSP, GH, NYBG); T'ao River basin, banks of T'ao, east of Choni, *Rock* 12880 (GH); T'ao River basin, Kadjaku Valley, *Rock* 13148 (ANSP, GH, USNH); near Pinfan, *Ching* 460 (ANSP, UC, USNH).

SHANSI: Mt. Wu-tai, *Tang* 1089 (NYBG).

CHAHAR: Hsiao-wu-tai Shan, *Meyer* 1193 A[20] (GH, NYBG, UCLA), *J. C. Liu* 1816 b (UC), *C. F. Li* 10739 (ANSP, NYBG), 11042 (NYBG), *T. P. Wang* 755 (NYBG).

The identity of this species has been much confused in the literature and the herbaria. The confusion dates from the author Maximowicz himself when he identified in 1888 (l.c.) *Potanin* s.n. from Kansu as this species, and herbarium sheets were accordingly labelled and distributed as such.

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[19] Some references to this pertain to other species: "*Pedicularis chinensis*" *sensu* Maxim., in Bull. Acad. St. Pétersb., 32: 534, 1888, p.p.; in Mél. Biol., 12: 796, 1888, p.p. (*Potanin* s.n.); Bonati, in Bull. Soc. Bot. France, 54: 183, 1907 (*Wilson* 4234); Limpricht, in Repert. Sp. Nov., 20: 250, 1924, p.p. (*Wilson* 4234); Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 33, 1933 (*Rock* 13101, 13355); *non* Maxim. 1878. The various specimens so referred to this species are actually *P. longiflora typica* except *Wilson* 4234 which is *P. longiflora tubiformis*.

[20] *Meyer* 1193 contains two elements which are here designated as A and B. The sheet in the Bonati Herbarium (to go to the University of California at Los Angeles) has only A, while the other two are composite. B is *P. rhinanthoides labellata*.

This specimen is actually the typical form of *P. longiflora*. Prain had early noted this fact (in Ann. Bot. Gard. Calcutta, 3: 113, 1890) when he said: "Of extra-Indian species *P. chinensis* Maxim., a distinct species in habit, stature, leaves and calyx much like certain forms of *P. megalantha*, comes near to this [*P. longiflora* Rudolph], but differs in having the lateral lobes of the lip rounded, not truncate, and in having the apex of the beak of corolla entire. A specimen of the original gathering of *P. chinensis* has been kindly sent to Calcutta by Mr. Maximowicz. Certain specimens from North China (Potanin, 1885) issued as '*P. chinensis*' from the St. Petersburg Herbarium are, however, only *P. tubiformis* Klotzsch, and therefore, are merely tall forms of *P. longiflora* Rudolph."

Later authors have made similar misidentifications. But *P. chinensis* is readily distinguishable from *P. longiflora* not only by the floral characters mentioned by Prain but also by the leaves being pinnatifid and bearing broad, rounded, and serrulate lobes. In *P. longiflora*, the leaves are more deeply cut, the lobes being narrower and pinnatifid. The galea of *P. chinensis* is somewhat curved at the very base and also proximally, forming, together with the beak, almost a circle. The lateral lobes of the lower lip are broad and rounded while the median lobe is as large as the lateral ones and is truncate.

271. Pedicularis decorissima Diels Plate 15, fig. 222.

Pedicularis decorissima Diels, in Notizbl. Bot. Gart. Berlin, 10: 891, 1930; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 33, 1933; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 211, 1934. The types were from eastern Chinghai: "Tibetia orientalis: 'Grasslands between Labrang and Yellow River, meadows between Hetso and Chiu ssu'; alt. 2900-3000 m.s.m. (flor. m. August 1926—Rock 14546—Typus speciei); ibidem, 'Grassy shopes [sic!] below Yobsha nira,' 3500 m.s.m. (fl. Juli 30—Rock 14357.'" Isotypes are in the herbarium of the Academy of Natural Sciences of Philadelphia and the Gray Herbarium.

Alpine meadows at altitudes of about 2900 to 3500 meters in eastern Chinghai and Sikang. Flowers rose-pink. Flowering in July and August.

CHINGHAI: between Labrang and Yellow River, between Hetso and Chiu ssu, *Rock* 14546 (ANSP, GH); between Labrang and Yellow River, below Yobsha nira, *Rock* 14537 (ANSP, GH, NYBG).

SIKANG: Baurong to Tatsienlu, via Hadjaha, *Stevens* 304 (CM).

A very striking plant resembling somewhat *P. armata* Maxim. and its relatives. However, it is readily distinguished by its pink flowers and the prominent crest as well as the dense pubescence on the galea. The apex of the beak is prolonged on the dorsal side to a club-shaped process which Diels did not describe. The galea is only slightly twisted. In several characters, this species is apparently a link between the yellow-flowered group of the series which has untwisted galea and the pink to purple-flowered group which has a strongly-twisted galea.

272. **Pedicularis humilis** Bonati Plate 15, fig. 223.

Pedicularis humilis Bonati, in Notes Bot. Gard. Edinb., 13: 106, 1921; Limpricht, in Repert. Sp. Nov., 20: 249, 1924. The type was from Yunnan: "'West China:—Shweli-Salween divide. Moist stony pasture. Lat. 25° 30′ N. Alt. 10,000 ft. Plant of 3-5 ins. Flowers rose. July 1913.' G. Forrest. No. 11,969." Isotypes are in the Bonati Herbarium and the herbarium of the University of California.

Alpine stony meadows at an altitude of about 3050 meters in northwestern Yunnan. Flowers rose. Flowering in July. Known from the original collection only.

YUNNAN: Shweli-Salween divide, *Forrest* 11969 (ANSP, UC).

A species clearly related to *P. delavayi* Franch. and allies, a group with pink to purple corolla and distinctly and strongly twisted galea. However, among these species *P. humilis* is distinguishable in having the shortest calyx and the shortest corolla-tube. The bilobed middle lobe of the lower corolla lip resembles that of *P. delavayi*. The low habit with its procumbent stem and the glabrous calyx are also distinctive.

273. **Pedicularis variegata** sp. nov. Plate 15, fig. 224.

Planta perennis, caespitosa, vix 15 cm. alta; radice singulā, elongatā leviter crassā, simplice; caulibus multis, diffusis vel erectis, simplicibus, pubescentibus; foliis caulinis vel radicalibus, similibus, alternis, longe petiolatis, ad 6.5 cm. longis, petiolis ad 2.5 cm. longis, leviter alatis, puberulis, laminis oblongo-ovatis vel oblongis, ad 4 cm. longis 1.4 cm. latis, utrinque hirsute pubescentibus, pinnatisectis, segmentis utrinsecus 9-12, ovatis, ad 4 mm. latis, obtusis, serratis, basi late adnatis; floribus subsessilibus, inferioribus axillaribus, laxis, superioribus numerosis, compactis; bracteis foliaceis, petiolatis, pinnatisectis; calyce campanulato, 7-9 mm. longo, superne valde lato, ad 6 mm. lato, membranaceo, sparse villoso, haud reticulato, antice fisso, 2-dentato, dentibus inaequalibus, dente posteriore minore, ovato, integro vel sub-integro, dentibus lateralibus breviter stipitatis, ovatis, valde inciso-serratis; corollā albidā galeā purpureā exceptā: tubo cylindrico, 3.5-4.5 cm. longo, 1 mm. lato, erecto, subglabro vel parce pubescente, haud dilatato; galeā valde tortā, glandulari-hirsutā, inconspicue longe cristatā, in rostrum concolore productā, rostro 9-10 mm. longo, prominente sigmoideo, apice integro; labio inferiore circiter 1.8-1.9 cm. lato, 8-9 mm. longo, margine minute ciliato, profunde 3-lobato, lobis valde inaequalibus, lobo medio valde minore, truncato vel rotundato, lobis lateralibus orbicularibus, integris, rarius bilobatis; staminibus apicem tubi insertis, filamentis anterioribus ad apicem parce villosis, inferioribus glabris, antheris ovoideis; stylo subexserto; capsulis ignotis.

Type, in swampy meadow at an altitude of 4150 meters in the mountains between Wa-Erh-Dje and Muli Gomba, Muli territory, Sikang Province, collected in flower, August 1928, by J. F. Rock, No. 16927; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotype in the United States National Herbarium. Flowers white with purple galea and beak.

SIKANG: Muli, *Rock* 16927 (ANSP, USNH), *Ward* 4794 (RBGE).

A strikingly characterized species related to *P. delavayi* Franch. and allies, but readily distinguishable. It is a many-stemmed plant with spreading habit. Among the distinct characters are the greatly expanded calyx, the white corolla with purple galea and the extremely small middle lobe of the lower corolla-lip. The lateral lobes are usually entire, but occasionally may be slightly bilobed.

274. Pedicularis paxiana Limpricht

Pedicularis paxiana Limpricht, in Repert. Sp. Nov., Beih. 12: 483, 1922; in Repert. Sp. Nov., 20: 249, 1924. The type, "Ost-Tibet: Dawo, Matten des Tales von Lumpu, oberhalb des Talschlusses Lartza, gagen den Passgrat Sllhä tschem la, 4300 m (n. 2008)," has not been seen.

In northeastern Sikang. Flowers white. Known from the original collection only. No specimen seen.

According to the description this species is a subacaulescent plant with characters approaching *P. bidentata* of which no specimen is available for study either. *P. paxiana,* however, is characterized by a white corolla with a tube 9-10 times as long as the calyx. It clearly belongs to the pink-purplish flowered group with twisted galea instead of the yellow-flowered group with untwisted galea. The original description is rather brief.

275. Pedicularis leptosiphon sp. nov. Plate 16, fig. 225.

Planta perennis, ad 2 dm. alta; caulibus pluribus, erectis vel subdiffusis, glabratis vel villosis; foliis caulinis vel radicalibus, similibus, alternis, longe petiolatis, ad 7.5 cm. longis, petiolis ad 4 cm. longis, leviter alatis, villosis, laminis glabrescentibus vel parce pubescentibus, oblongis vel lineari-oblongis, ad 3.5 cm. longis, 1.1 cm. latis, pinnatisectis, segmentis utrinsecus 8-11, remotis, ovatis, ad 3 mm. latis, obtusis, serratis; floribus subsessilibus, inferioribus axillaribus, laxis, superioribus numerosis, densis; bracteis foliaceis, petiolatis, pinnatisectis; calyce cylindrico, circiter 1 cm. longo 3 mm. lato, membranaceo, parce villoso, vix reticulato, antice fisso, 3-5-dentato, dentibus inaequalibus, dente posteriore minore, ovato, serrato, dentibus 2 lateralibus majoribus, ovatis, pinnatisectis, segmentis serratis, dentibus 2 anterioribus minoribus serratis, interdum nullis; corollā albidā: tubo cylindrico, 6.5-7.5 cm. longo 1 mm. lato, recto, glabrato, haud dilatato; galeā valde tortā, glandulari-hirsutā, inconspicue sublevatā, 9-10 mm. longā, sigmoideā, apice subfidā; labio inferiore circiter 1.7 cm. lato 8 mm. longo, margine minute ciliatis, profunde 3-lobato, lobis inaequalibus, lobo medio lato, truncato, lobis lateralibus suborbicularibus, rotundatis; staminibus apicem tubi insertis, filamentis anterioribus ad apicem parce villosis, inferioribus glabris, antheris ovoideis; stylo incluso; capsulis ignotis.

Type, in alpine meadows at an altitude of 4000 meters in the mountains of Kulu, Muli territory, Sikang Province, collected in flower, July 1929, by J. F. Rock, No. 18012; holotype in the United States National Herbarium; isotype in the herbarium of the Academy of Natural Sciences of Philadelphia. Flowers white. Only collection seen.

Although this is a purely white-flowered species, its association, in view of the long corolla-tube and the strongly twisted galea, is clearly with *P. delavayi* Franch. and allies. The most distinct characters, besides the white corolla, are the calyx-teeth and the lower corolla-lip. The calyx-teeth are either 3 or 5, the 2 antero-lateral ones being much smaller and sometimes absent. The 2 large lateral teeth are characteristically pinnatisect. The median lobe of the lower lip is truncate and broader than the lateral ones.

276. **Pedicularis dolichantha** Bonati Plate 16, fig. 226.

Pedicularis dolichantha Bonati, in Notes Bot. Gard. Edinb., 13: 107, 1921; Limpricht, in Repert. Sp. Nov., 20: 249, 1924. The types were from: "Eastern Yunnan:—'Pedicularis annuel, isolé, dressé; fl. rose sombre. Pâturages—haut plateau de Iéma-tschouan. Alt. 3200 m. Août 1913.' E. E. Maire. No. 672. Eastern Yunnan:—'Scrophularinée annuelle. Fl. roses. Lagunes du haut plateau de Ta-hai. Alt. 3200 m. Juillet 1913.' E. E. Maire. No. 688." Duplicates of both syntypes are in the Bonati Herbarium.

Alpine meadows at an altitude of about 3200 meters in northeastern Yunnan. Flowers rose. Flowering in July and August. Known from the original collections only.

YUNNAN: Ie-ma-tchouan, *Maire* 672 (ANSP, UCLA); Ta-hai, *Maire* 688 (UCLA).

This species is near *P. delavayi* Franch. but is located geographically in the east beyond the range of the latter. It is readily distinguished by its galea bearing an elongated but inconspicuous crest, by its long and sigmoid beak, and by the median lobe of the lower corolla-lip being not emarginate nor bilobed. The calyx is thick and densely pubescent and has always 2 teeth which are very deeply cut.

277. **Pedicularis tenuituba** Pennell & Li, sp. nov. Plate 16, fig. 227.

Planta perennis, ad 3 dm. alta; radice singulā, elongatā, leviter crassā, simplice, caulibus pluribus, circiter 20 cm. altis, simplicibus, glabris vel parce villosis; foliis radicalibus vel caulinis, radicalibus ad 13 cm. longis, petiolis ad 4 cm. longis, leviter alatis, villosis, laminis oblongis vel linearibus, ad 9 cm. longis 1.6 cm. latis, subglabris vel parce pubescentibus, pinnatisectis, segmentis utrinsecus 10-15, remotis, ovatis, ad 5 mm. latis, obtusis, serratis, basi late adnatis, foliis caulinis alternis, rarius subopposititis, radicalibus similibus aut leviter minoribus; floribus axillaribus, inferioribus laxis superioribus numerosis, compactis, subsessilibus vel breviter pedicellatis; bracteis foliaceis, petiolatis, petiolis villosis, laminis pinnatisectis; pedicellis ad 3 mm. longis; calyce cylindrico, 7-8 mm. longo, membranaceo, vix reticulato, villoso, antice fisso, 3-dentato, dentibus inaequalibus, dente posteriore minore, lanceolato, superne serrato, dentibus lateralibus ovatis, stipitatis, pinnatifidis vel serratis; corollā purpureā: tubo cylindrico, 8-11 cm. longo, vix 1 mm. lato, erecto, glabro vel sparse puberulo, haud dilatato; galeā prominente tortā, glandulari-hirsutā, fronte inconspicue longe cristatā, in rostrum longum productā; rostro sublevato, circiter 8-10 mm. longo, prominente sigmoideo, apice subbilobato; labio inferiore circiter 1.4-1.6 cm. lato, 8-9 mm. longo, margine ciliato, profunde 3-lobato, lobis subaequalibus, lobo medio truncato, lobis lateralibus orbicularibus; staminibus ad apicem tubi insertis, filamentis anterioribus ad apicem villosis, posterioribus glabris, antheris ovoideis; stylo incluso vel vix exserto; capsulis oblongis, acuminatis, obliquis, circiter 1.7 cm. longis, 6 mm. latis, leviter compressis, ½ calyce inclusis.

Type, in meadows at an altitude of 3080 meters, in the mountains of Muli and Kulu, Sikang Province, collected in flower, Aug. 1929, by J. F. Rock, No. 17403; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotype in the United States National Herbarium.

SIKANG: mountains of Kulu, east of Muli Gomba, *Rock* 16449 (ANSP, USNH); mountains of Muli and Kulu, *Rock* 17403 (ANSP, USNH); mountains of Kulu, *Rock* 18087 (ANSP, USNH); Mt. Siga, northeast of Kulu, *Rock* 18125 (ANSP, USNH).

Of all species of Pedicularis this has the most slender and longest corolla-tube. From *P. delavayi* it is readily distinguished by its taller and more hairy habit, its long stipitate calyx-teeth, its darker corolla with longer tube and less spreading lower lip, and its truncate instead of bilobed middle lobe of the lower lip. From *P. dolichantha* it may be distinguished by the longer and more glabrous corolla-tube and the thinner and less hairy calyx with 3 instead of 2 calyx-teeth.

278. Pedicularis sigmoidea Franchet Plate 16, fig. 228.

Pedicularis sigmoidea Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 535, fig. 12, 1888; in Mél. Biol., 12: 776, fig. 12, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 216, 1890; Bonati, in Notes Bot. Gard. Edinb., 8: 37, 1913; 15: 164, 1926; Limpricht, in Repert. Sp. Nov., 20: 251, 1924; 23: 338, 1927. The type was from "Yunnan, monte Koua-la-po prope Ho-kin, 3000 m.s.m. (Delavay!)." This is *Delavay* 960, collected on August 26, 1884. Two isotypes with several specimens are in the Bonati Herbarium from which they pass to the Academy of Natural Sciences of Philadelphia and the University of California at Los Angeles. Another with a single specimen is in the New York Botanical Garden.

Open stony pastures at altitudes of 3000 to 3600 meters in northwestern Yunnan. Flowers rose to purple. Flowering in August and September.

YUNNAN: no precise locality, *Forrest* 7023 (UCLA); Yen-tze-hay, *Delavay* s.n. (UCLA); Ho-kin, *Delavay* s.n. (NYBG, UCLA), 960 (ANSP, NYBG, UCLA); Ma-eul-chan, *Delavay* s.n. (NYBG); Tong-shan on the Yangtze bend, *Forrest* 10836 (ANSP, NTU, UC); Likiang, *Schneider* 3082 (GH, USNH); Sung-kwei mountains between Likiang and Talifu, *Rock* 6306 (ANSP, UC, USNH); Chungtien Plateau, *Yü* 13619 (AA); Yu-lung Shan, Likiang Snow Range, *Rock* 25356 p.p. (UC p.p., UP).

This species is readily recognized by its tall habit. The flowers are very numerous, scattered and axillary on the proximal part of the stem and dense and compact distally. The long-tubular corolla with its long slender and strongly sigmoid beak is very distinctive.

279. Pedicularis latituba Bonati

Pedicularis latituba Bonati, in Bull. Soc. Bot. France, 55: 243, 1908; Limpricht, in Repert. Sp. Nov., 20: 251, 1924. The type, "Yargong (*Soulié*) nº 3754, 1903," has not been seen.

In Sikang. Flowers purple. Known from the original collection only. No specimen seen.

According to Bonati, this species is near *P. siphonantha* D. Don, but is distinguished by its relatively large (3-4 cm. long and 2 mm. wide) corolla-tube, its long pedicels (2 cm. long), and its all villose filaments. The galea and beak resemble those of *P. mussoti* Franch. It is doubtful whether this species belongs to the Longiflorae or the Muscicolae. Its exact identity is uncertain until the type can be studied.

280. Pedicularis delavayi Franchet Plate 16, fig. 229.

Pedicularis delavayi Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 531, fig. 7, 1888; in Mél. Biol., 12: 791, fig. 7, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 208, 1890; Bonati, in Bull. Herb. Boiss. II, 7: 541, 1907; in Notes Bot. Gard. Edinb., 5: 80, 1911; 7: 149, 1912; 8: 37, 1913; 15: 163, 1926; Limpricht, in Repert. Sp. Nov., Beih., 12: 483, 1922; in Repert. Sp. Nov., 20: 249, 1924; 23: 338, 1927; Gilmour, in Curtis' Bot. Mag., 157: pl. 9367, 1934. The type was from "Yunnan, Li-kiang monte Sueechan collibus calcareis 4000 m.s.m. (Delavay!)." An isotype is in the Bonati Herbarium. It was collected on August 14, 1886.

"*Pedicularis siphonantha*" *sensu* Franch., in Nouv. Arch. Mus. Hist. Nat. Paris II, 10: 184, 1888 (Pl. David. II); Maxim., in Bull. Acad. St. Pétersb., 32: 534, 1888; in Mél. Biol., 12: 796, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 216, 1890; Bonati, in Bull. Herb. Boiss. II, 7: 541, 1907; in Bull. Soc. Bot. France, 54: 183, 1907; in Notes Bot. Gard. Edinb., 5: 79, 1911; 7: 81, 1912; 8: 37, 1913; Limpricht, in Repert. Sp. Nov., Beih., 12: 484, 1922; in Repert. Sp. Nov., 20: 251, 1924; 23: 338, 1928; Marquand, in Journ. Linn. Soc. Bot., 48: 214, 1929; Pai, in Contr. Inst. Bot. Nat. Peiping, 2: 219, 1934; Hand.-Maz., Symb. Sin., 7: 865, 1936; *non* D. Don. The typical form of *P. siphonantha* D. Don, originally collected by Wallich in Nepal, is limited in its distribution to the eastern Himalayas. As Pennell noted in Monogr. Acad. Nat. Sci. Phila., 5: 156, 1943) "*Pedicularis siphonantha,* at least its typical form, does not occur in Yunnan and Szechuan, western China, although close relatives there show corollas of similar great length." The Chinese plants referred to this species are clearly identical with *P. delavayi*. Early collections in the Bonati Herbarium, identified by Maximowicz as representing *P. siphonantha,* are exactly the same as *P. delavayi*. From the later collections made by Forrest, Rock, etc., Bonati assigned identical plants to either species. The apparent reason for this unwarranted recognizance and perpetuation of the name of this Indian plant in the Chinese flora is due to the fact that *P. delavayi* was described as having 5 calyx-teeth. This character has been been considerably emphasized by different authors to differentiate it from *P. siphonantha* D. Don, which has 2 or 3 calyx-teeth. Actually, as noted below, both the type specimens and later collections show that in *P. delavayi* the calyx-teeth vary in number; usually they are 2 or 3 but sometimes may be 5. Thus with the breakdown of this calyx-teeth character all Chinese plants named *P. siphonantha* by different authors fall within the concept of *P. delavayi*.

Alpine meadows at altitudes of 3000 to 4600 meters in northwestern Yunnan and eastern Sikang. Flowers purple-red to purple. Flowering in June and July.

SIKANG: Tatsienlu, *Potanin* s.n. (UCLA); Tongolo, *Soulié* 298 (ANSP, NTU, UCLA), 423 (UCLA); between Woloho and Choso, *Schneider* 1587 (USNH); Ka-gwr-pw, Mekong-Salween divide, *Forrest* 14439 (UCLA); Muli territory, Wa-Erh-Dje Snow Range, *Rock* 6486 (USNH); Mount Konka, Risonquemba, Konkaling, *Rock* 16304 (ANSP, USNH), 16405a (USNH); Muli territory, mountains between the Litang and Yalung Rivers, between Muli Gomba and Baurong and Wa-Erh-Dje, *Rock* 16713 (ANSP, USNH); Yuling-gong, Djesi-La and Djesi-Longba, south of Tatsienlu, *Rock*

17545 (ANSP, USNH); Minya Konka Snow Range, east of Yulong Hsi, *Rock* 17660 (ANSP, USNH); Muli territory, mountains of Kulu, *Rock* 18111 (ANSP, USNH), 23943 (CM, MBG, NYBG, UC, UP, USNH); Muli, *Ward* 4544 (RBGE), 4745 (RBGE); no data, *Ward* s.n. (RBGE).

YUNNAN: no precise localities, *Forrest* s.n. (UCLA), 2638 (UCLA), 5078 (ANSP), 6038 (UCLA), 6385 (UCLA), 6479 (NTU), 6596 (UCLA), 28849 (ANSP), 29878 (ANSP), *Yü* 6823 (AA), 7010 (AA), 7620 (AA), 9039 (AA), 12343 (AA), 12998 (AA); Likiang, *Delavay* s.n. (ANSP); Likiang, Suee Chan, *Delavay* s.n. (UCLA); eastern slopes of Likiang Snow Range, *Rock* 4641 (GH, USNH), 5466 (NYBG, USNH), 9441 (USNH), 9830 (USNH), 9885 (ANSP, UC, USNH), 9913 (ANSP, GH, UC, USNH); Mount Peimashan, Mekong-Salween divide, between Atuntze and Pungtzera, *Rock* 10007 (NYBG, USNH); Mountains of Hung-po west of Tung-chu-ling, overlooking Mekong and west of Pei-ma-shan, *Rock* 22877 (NYBG, UC, UP, USNH); Haba Shan, north of the Yangtze loop, third peak of Likiang Snow Range, Bardar, *Rock* 24743 (CM, MBG, NYBG, UC, UP, USNH); eastern slopes of Likiang Snow Range, Yu-lung Shan, Mt. Satseto, *Rock* 24883 (CM, MBG, NYBG, UC, UP, USNH); Likiang, *Schneider* 1961 (USNH); Wei-si District, Kang-pu, *C. W. Wang* 64667 (AA); Wei-si District, *C. W. Wang* 67826 (AA), *Tsai* 59598 (AA); Atuntze, Beimashan, *C. W. Wang* 69478 (AA); Li-kiang District, *C. W. Wang* 71127 (AA); Likiang Snow Range, *Yü* 15244 (AA); Hsiao Chungtien, south of Chungtien, *Feng* 1389 (AA); Chungtien Plateau, *Feng* 1535 (AA); Likiang Snow Range, *Ching* 30380 (AA).

This species, as originally described, has 5 calyx-teeth and all the filaments hairy, the anterior ones being densely so. In the type specimen available, and in the large series of specimens subsequently collected, the characters do not agree with this described condition. Evidently the conception of the species needs revision. The anterior filaments are densely hairy distally but the posterior ones are glabrous. The majority of the specimens as well as the type show that normally 3 calyx-teeth are present, the posterior one being smaller. Five teeth are sometimes present but the condition is not very common. Apparently the number of calyx-teeth varies in this species, and as the variations are sometimes present on the same specimen this character cannot be used alone for specific differentiation.

Because of the confusion with regard to the calyx-teeth some of the Chinese specimens have been referred to *P. siphonantha* D. Don, an Indian species. *P. delavayi* is close to the latter, resembling it in all major characters. However, the typical form of *P. siphonantha* is apparently limited in its distribution to the Eastern Himalayas and does not extend eastward. The galea of *P. siphonantha* is less twisted, the proximal part being erect and distinctly auriculate-dentate on each side of the margins. In *P. delavayi* the galea is strongly twisted at its proximal part and is devoid of the auriculate teeth.

P. delavayi is the most abundant of the species with long tubes, long beaks and twisted galea. It is apparently the most successful in finding its abode in the high mountains of western China and in attracting the insect-visitors that are adapted to its peculiar floral structure. The method of pollination in this curiously constructed flower will be an interesting and desirable study.

281. Pedicularis dolichosiphon (Handel-Mazzetti) comb. nov. Plate 16, fig. 230.

Pedicularis siphonantha D. Don var. *dolichosiphon* Hand.-Maz., in Anz. Sitz. Akad. Wiss Wien, Math.-Nat. Kl., 60: 117, 1923; Symb. Sin., 7: 865, 1936; Limpricht, in Repert. Sp. Nov., 20: 252, 1924. The type was from Sikang: "Prov. Setschwan austro-occ.: Supra monasterium Muli in pineto-quercetis apertis regionis temperatae ad pascuum Djatsiila, s[olo] arenaceo, ca. 3425 *m*, legi 3. VIII. 1915 (Nr. 7391)." An isotype in the Bonati Herbarium will pass to the University of California at Los Angeles.

Perennial, low plant, subacaulescent or short-stemmed; roots simple, straight, long, slightly thickened; stems single or several, to 13 cm. tall, simple, densely long-villose; leaves radical and cauline, similar, alternate to subopposite, long-petiolate, to 3.5 cm. long, the petioles to 1.5 cm. long, slender, slightly winged, densely villose, the blades ovate to oblong-ovate, to 2 cm. long and 1 cm. wide, slightly pubescent to glabrate, pinnatisect, the segments 8-13 on each side, remote, oblong, obtuse, to 3 mm. wide, slightly narrowed at base, pinnatifid, the lobules serrate, the serrations cartilagenous; flowers compactly arranged toward the distal part of the stem, sessile to subsessile; bracts similar to the leaves; calyx cylindric, about 7-8 mm. long, villose, scarcely reticulate, cleft anteriorly, 3-dentate, the teeth unequal, the posterior one small, lanceolate, subentire to dentate distally, the lateral ones ovate, deeply incised-dentate, long- and slender-stipitate; corolla rose to purple, the tube about 6 cm. long and 1 mm. wide, erect, sparsely hairy externally, not enlarged distally; galea strongly twisted, glandular-hirsute in front, narrowly and inconspicuously crested, the apex produced into a long slender upraised beak about 1 cm. long, the beak strongly curved into a semi-circle or rarely sigmoid, the apex entire, not bilobed; lower lip to 2 cm. wide and 1.1 cm. long, the margins finely ciliate, strongly 3-lobed, the lobes subequal, the lateral orbicular, rounded, the median emarginate to shallowly bilobed; stamens inserted near the apex of the tube, the anterior filaments villose distally, the posterior filaments glabrous; stigma slightly exserted; capsules unknown.

Alpine meadows at altitudes of 3425 to 3660 meters, in northwestern Yunnan and southern Sikang. Flowers pale rose to purple. Flowering in August.

SIKANG: Muli, Djatsiila, near Youngning, *Handel-Mazzetti* 7391 (UCLA); Tatsienlu, *Cunningham* 183 (RBGE).

YUNNAN: Mt. Wuaha, Youngning territory, *Rock* 24244 (CM, MBG, NYBG, UC, UP, USNH).

A species related to *P. delavayi* Franch., differing in the densely villose petioles and stems, the narrower leaf-segments with cartilaginous serrations on the margins, the shorter calyx-tube with long and slenderly stipitate teeth and the slightly wider corolla-lip with a less deeply lobed median lobe.

282. Pedicularis fastigiata Franchet

Pedicularis fastigiata Franch., in Bull. Soc. Bot. France, 47: 25, 1900; Limpricht, in Repert. Sp. Nov., 20: 255, 1924. The type, "Yunnan, au voisinage du Mé-kong, vers Tsiten (Pce Henri d'Orléans)," has not been seen.

In northwestern Yunnan. Flowers rose. Known from the original collections only. No specimen seen.

This is an imperfectly known species. Franchet originally suggested that its relationship was with *P. garckeana* Prain, an Indian species of the series Robustae, but said that the long corolla-tube (4 cm. long) and the arrangement of the flowers were different from that group. Limpricht accordingly included this species in that series, which is apparently unwarranted. It is suspected that it belongs to the Longiflorae. It was, however, described as having 5 calyx-teeth and all the filaments glabrous, a combination which suggests possible relationship to the series Muscicolae. Without actual access to type specimens it is impossible to make out the exact status of *P. fastigiata.* According to Franchet the type at the Paris Museum is an incomplete specimen.

PHOTOGRAPHS OF TYPE SPECIMENS AT THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA

In preparing Dr. Li's manuscript for printing we should have mentioned uniformly in the discussion of nomenclature under each species whether, failing actual representation by specimen, there was present in the Academy's herbarium a photograph of a type or isotype. Unfortunately, so many such cases were overlooked in Part I as to make it seem best to present now a summary list of all such phototypes. For each of these is stated the province in China whence obtained, its collector and number (or year), in what herbarium seen (denoted by abbreviation), and whether it be type or isotype.

P. alaschanica Maxim.—Kansu—*Przewalski* in 1872 (UCLA)—Isotype
P. aloensis Hand.-Mazz.—Yunnan—*Handel-Mazzetti* 4582 (UCLA)—Isotype
P. amplituba Li—Yunnan—*Yü* 16939 (AA)—Type
P. atuntsiensis Bonati—Yunnan—*Ward* 115, in 1911 (RBGE)—Type
P. balfouriana Bonati—Yunnan—*Forrest* 4489 (RBGE)—Type
P. bambusetorum Hand.-Mazz.—Yunnan—*Handel-Mazzetti* 9034 (RBGE)—Isotype
P. brachycrania Li—Yunnan—*Rock* 25090 (USNH)—Type
P. cephalantha Franch.—Yunnan—*Delavay* 98, in 1887 (UCLA)—Isotype
P. cernua latifolia Li—Yunnan—*Yü* 19784 (AA)—Type
P. corydaloides Hand.-Mazz.—Yunnan—*Handel-Mazzetti* 9515 (GH)—Isotype
P. cyclorhyncha Li—Yunnan—*Ching* 20951 (AA)—Type
P. dielsiana Bonati— . . . . —*Wilson* 4246 (UCLA)—Type
P. dissectifolia Li—Yunnan—*Yü* 6866 (AA)—Type
P. dolichoglossa Li—Yunnan—*Yü* 6924 (AA)—Type
P. dolichostachya Li—Szechwan—*Wang & Wen* 648 (AA)—Type
P. elwesii major Li—Sikang—*Rock* 22251 (NYBG)—Type
P. elwesii minor Li—Sikang—*Rock* 22167 (NYBG)—Type
P. fengii Li—Yunnan—*Feng* 2101 (AA)—Type
P. filicifolia Hemsl.—Hupeh—*Henry* 6105 (NYBG)—Type
P. glabrescens Li—Yunnan—*Yü* 8751 (AA)—Type
P. gracilicaulis Li—Yunnan—*Wang* 64788 (AA)—Type

P. gracilituba setosa Li—Yunnan—*Yü* 12060 (AA)—Type
P. hemsleyana Prain—Szechwan—*Pratt* 684 (RBGE)—Isotype
P. henryi Maxim.—Hupeh—*Henry* 6155 (NYBG)—Type
P. imperialis Franch.—Yunnan—*Delavay* 6899 (NYBG)—Isotype
P. infirma Li—Yunnan—*Yü* 20060 (AA)—Type
P. insignis Bonati—Yunnan—*Ward* 1105, in 1913 (RBGE)—Type
P. lacerata Bonati—Yunnan—*Ward* 935, in 1913 (RBGE)—Type
P. lasiantha Li—Hupeh—*Wilson* 2182 (USNH)—Type
P. laxiflora Franch.—Szechwan—*Farges* (NYBG)—Isotype
P. laxispica Li—Yunnan—*Yü* 12598 (AA)—Type
P. leptosiphon Li—Szechwan—*Rock* 18012 (USNH)—Type
P. lineata Franch.—Yunnan—*Delavay* in 1886 (NYBG)—Isotype
P. lipskyana Bonati—Szechwan—*Potanin* in 1893 (UCLA)—Type
P. lophocentra Hand.-Mazz.—Szechwan—*Handel-Mazzetti* 7144 (UCLA)—Isotype
P. lutescens longipetiolata Li—Sikang—*Wang* 65534 (AA)—Type
P. macrorhyncha Li—Yunnan—*Feng* 1595 (AA)—Type
P. magnini Bonati—Yunnan—*Rock* 3307 (USNH)—Isotype
P. maxonii Bonati—Yunnan—*Rock* 6146 (USNH)—Isotype
P. megalopha Li—Yunnan—*Yü* 22284 (AA)—Type
P. membranacea Li—Sikang—*Chiao* 1657 (AA)—Type
P. meteororhyncha Li—Yunnan—*Rock* 25184 (USNH)—Type
P. micrantha Li—Yunnan—*Yü* 20344 (AA)—Type
P. moschata Maxim.—Mongolia—*Potanin* in 1877 (UCLA)—Isotype
P. muliensis Hand.-Mazz.—Sikang—*Handel-Mazzetti* 7419 (RBGE)—Isotype
P. muscoides Li—Szechwan—*Rock* 16343 (USNH)—Type
P. obscura Bonati—Yunnan—*Rock* 4480 (USNH)—Isotype
P. omiiana Bonati—Szechwan—*Wilson* 5079 (UCLA)—Isotype
P. omiiana diffusa Bonati—Szechwan—*Wilson* 4235 (UCLA)—Isotype
P. pantlingii chimiliensis Bonati—Burma—*Farrer* 1143 (RBGE)—Type
P. pectinatiformis Bonati—Sikang—*Soulié* 2868 (UCLA)—Type or isotype
P. pilostachya Maxim.—Kansu—*Przewalski* in 1872 (UCLA)—Isotype
P. plicata Maxim.—Kansu—*Potanin* in 1885 (UCLA)—Isotype
P. polyphylla Franch.—Yunnan—*Delavay* 206, in 1884 (NYBG)—Isotype
P. porphyrantha Li—Szechwan—*Wang & Wen* 610, in 1938 (AA)—Type
P. praealta Bonati—Yunnan—*Maire* 673, in 1913 (RBGE)—Type
P. przewalskii australis Li—Yunnan—*Rock* 22840 (USNH)—Type
P. pseudo-ingens Bonati—Yunnan—*Ward* 130, in 1911 (RBGE)—Type
P. quadrata Bonati—Sikang—*Ward* 812, in 1913 (RBGE)—Type
P. rex pseudocyathus Vaniot—Kweichow—*Bodinier* 1594 (RBGE)—Isotype
P. rex thamnophila Hand.-Mazz.—Szechwan—*Handel-Mazzetti* 7186 (USNH)—Isotype
P. rudis Maxim.—Ninghsia—*Przewalski* 186, in 1873 (UCLA)—Isotype
P. sigmoidea Franch.—Yunnan—*Delavay* 960, in 1884 (NYBG)—Isotype
P. siphonantha dolichosiphon Hand.-Mazz.—Sikang—*Handel-Mazzetti* 7391 (UCLA)—Isotype
P. smithiana Bonati—Yunnan—*Forrest* 2860 (UCLA)—Isotype
P. stewardii Li—Kweichow—*Steward, Chiao, & Cheo* 491 (NYBG)—Type
P. strobilacea Franch.—Yunnan—*Delavay* 3402, in 1888 (NYBG)—Isotype
P. subacaulis Bonati—Yunnan—*Rock* 5259 (NYBG)—Isotype

P. szetschuanica elata Bonati—Hupeh—*Wilson* 2119 (USNH)—Isotype
P. szetschuanica ovatifolia Li—Kansu—*Potanin* in 1885 (UCLA)—Type
P. tangutica Bonati—Kansu—*Przewalski* in 1880 (RBGE)—Type
P. tenuisecta Franch.—Yunnan—*Delavay* 329, in 1882 (NYBG)—Isotype
P. tomentosa Li—Yunnan—*Yü* 13112 (AA)—Type
P. tongtchouanensis Bonati—Yunnan—*Maire* (RBGE)—Type
P. torta Maxim.—Szechwan—*Potanin* in 1885 (UCLA)—Isotype
P. trichomata Li—Yunnan—*Yü* 6437 (AA)—Type
P. tricolor Hand.-Mazz.—Yunnan—*Handel-Mazzetti* 7526 (UCLA)—Isotype
P. truchetii Bonati—Yunnan—*Rock* 5913 (USNH)—Isotype
P. tsaii Li—Yunnan—*Tsai* 58287 (AA)—Type
P. tsarungensis Li—Sikang—*Rock* 22261 (NYBG)—Type
P. tsekouensis Bonati—Yunnan—*Soulié* 1087 (UCLA)—Isotype
P. tsiangii Li—Kweichow—*Tsiang* 7391 (NYBG)—Type
P. umbelliformis Li—Yunnan—*Yü* 11740 (AA)—Type
P. vagans Hemsl.—Szechwan—*Faber* in 1887 (UCLA)—Isotype
P. viali Franch.—Yunnan—*Delavay* 3378 (NYBG)—Isotype
P. violascens Schrenk—Dzungaria—*Schrenk* 741 (NYBG)—Isotype
P. wangii Li—Yunnan—*Wang* 68960 (AA)—Type
P. wettsteiniana Bonati—Yunnan—*Forrest* 6984 (RBGE)—Type
P. yui Li—Yunnan—*Yü* 19382 (AA)—Type

BIBLIOGRAPHY

In this I have included the important works bearing on the taxonomy of the genus *Pedicularis* in China and adjacent countries. Occasional references to this subject, which are cited in the text, are not listed. References to general discussions on geographical distribution, notes on collectors and their collections, etc., are also given in the text or in the footnotes only.

1. BENTHAM, G. Scrophularineae Indicae. 1-57. 1835.
2. ———. Pedicularis. In G. G. Walpers, Repertorium botanices Systematicae, 3: 409-433. 1844.
3. ———. Scrophulariaceae. In DeCandolle, Prodromus Systematis naturalis regni Vegetabilis, 10. 1846. (*Pedicularis*, pp. 560-582.)
4. BONATI, G. Les Pediculaires du Kouy-Tchéou de l'herbier Bodinier. In Bull. Acad. Intern. Géogr. Bot., 13: 240-245. 1904.
5. Les Pédiculaires de la Chine centrale dans l'herbier Boissier. In Bull. Herb. Boiss. II, 7: 541-545, 1 fig. 1907.
6. ———. Les Pédiculaires de Chine de M. Wilson dans l'herbier du Muséum de Paris. In Bull. Soc. Bot. France, 54: 183-188. 1907.
7. ———. Sur quelques espèces nouvelles du genre Pedicularis. In Bull. Soc. Bot. France, 54: 371-377. 1907.
8. ———. Sur quelques Pédiculaires chinoises nouvelles. In Bull. Soc. Bot. France, 55: 242-248, 310-314. 1908.
9. ———. Scrofulariancées nouvelles de l'Indo-Chine. In Bull. Soc. Bot. France, 55: 509-515, 537-543. 1908.
10. ———. Sur quelques Primulacées et Scrofularinées nouvelles de la Chine et de l'Indo-Chine. In Bull. Soc. Bot. France, 56: 464-469. 1909.
11. ———. Contribution à l'étude du genre Pedicularis. In Bull. Soc. Bot. France, 57, Mém. 18: 1-35. 1910.
12. ———. Les Pédiculaires du Sikkim-Himalaya de MM. Smith et Cave. In C. R. Congrès Soc. Sav., 109-113. 1910.
13. ———. Sur quelques espèces nouvelles ou peu connues du genre Pedicularis. In Bull. Soc. Bot. France, 57. Sess. Extraord.: lviii-lxi. 1911.
14. ———. Plantae Chinenses Forrestianae. Enumeration and description of species of Pedicularis. In Notes Bot. Gard. Edinb., 5: 79-92, pls. 70-75. 1911; 8: 37-45. 1913.
15. ———. Sur un Pedicularis critique du Kan-Sou. In Bull. Soc. Bot. Genève II, 4: 326-329. 1912.
16. ———. Sur deux Pedicularis du Yunnan occidental. In Bull. Soc. Bot. Genève II, 5: 112-113. 1913.
17. ———. Primulacées, Solanacées et Scrofulariacées nouvelles de la Chine, de l'Indo-Chine et du Turkestan. In Bull. Soc. Bot. Genève II, 5: 297-316, figs. 1-13. 1913.
18. ———. Sur quelques espèces du genre Pedicularis du Caucase et du Turkestan russe. In Bull. Soc. Bot. France, 61: 229-235, 1 pl., 289-294, 1 pl. 1914.
19. ———. Le genre Pedicularis L. Morphologie, classification, distribution géographique, évolution et hybridation, i-x, 1-168, 1 pl. 1918.

20. ————. New species of the genera Phtheirospermum and Pedicularis. In Notes Bot. Gard. Edinb., 13: 103-148. 1921.

21. ————. Scrophulariaceae novae. In Bull. Soc. Bot. Genève II, 15: 93-114. 1924.

22. ————. Scrofulariacées du Yunnan occidental récoltées par M. J. Rock. In Notes Bot. Gard. Edinb., 15: 147-172. 1926.

23. ————. Sur deux espèces nouvelles du genre Pedicularis du Yunnan occidental. In Arch. Bot. (Caen) Bull., 1: 3-5. 1927.

24. ————. Sur trois espèces nouvelles du genre Pedicularis. In Arch. Bot. (Caen) Bull., 1: 217-219. 1927.

25. Bunge, A. Pedicularis. In Ledebour, C. F. von, C. A. Meyer, and A. Bunge, Flora Altaica, 2: 424-438. 1830.

26. ————. Ueber eine neue Art der Gattung Pedicularis. In Bull. Acad. Sci. St. Pétersb., 8: 241-253. 1841.

27. ————. Note sur le Pedicularis comosa et les espéces coisines. In Ann. Sci. Nat. III. Bot., 3: 312-320. 1845.

28. ————. Ueber Pedicularis comosa L. und die mit ihr verwandten Arten. In Bull. Phys. Math. Acad. Sci. St. Pétersb., 1: 369-384. 1846.

29. ————. Pedicularis. In Ledebour, C. F. von. Flora Rossica, 3: 268-303. 1849.

30. Bureau, E., and A. Franchet. Plantes nouvelles du Thibet et de la Chine occidentale recueillies pendant le voyage de M. Bonvalot et du Prince Henri d'Orléans en 1890. In Morot, Journ. de Bot., 5: 103-109, 128-130. 1891.

31. Diels, L. Die Flora von Central China. In Bot. Jahrb., 29: 169-659. 1900-01. (*Pedicularis*, pp. 570-572. 1900.)

32. ————. Beiträge zur Flora des Tsin ling Shan und andere Zusätze zur Flora von Central-China. In Bot. Jahrb. 36. Beibl., 82: 1-138. 1905. (*Pedicularis*, pp. 96-97.)

33. ————. Beschreibung der auf der Forschungsreise durch Asien gesammelten Pflanzen. In Futterer, K. Durch Asien, 3: 1-24. *t. 1-4*. 1911. (Scrophulariaceae, pp. 20-21. *t. 3B*.)

34. ————. Plantae Chinenses Forrestianae. Catalogue of all the plants collected by George Forrest during his first exploration of Yunnan and eastern Tibet in the years 1904, 1905, 1906. In Notes Bot. Gard. Edinb., 7: 1-411. 1912-13. (*Pedicularis* identified by G. Bonati.)

35. ————. Miscellanea sinensia. III. In Notizbl. Bot. Gart. Berlin, 10: 881-892. 1930.

36. Don, D. Prodromus florae Nepalensis. i-xii, 1-256. 1825. (*Pedicularis*, pp. 94-95.)

37. Edinburgh, Royal Botanic Garden, Staff of. Diagnoses specierum novarum chinensium in herbaris Horti Regii Botanici Edinburgensis cognitraum. I-L. In Notes Bot. Gard. Edinb., 8: 105-136. 1913. (*Pedicularis* described by G. Bonati.)

38. ————. Plantae Chinenses Forrestianae. Catalogue of plants (excluding Rhododendron) collected by George Forrest during his fifth exploration of Yunnan and eastern Tibet in the years 1921-22. In Notes Bot. Gard. Edinb., 14: 75-393. 1924.

39. ————. Plantae Chinenses Forrestianae. Catalogue of all the plants collected by George Forrest during his fourth exploration of Yunnan and eastern Tibet in the years 1917-19. In Notes Bot. Gard. Edinb., 17: 1-406. 1929-30.

40. Fedde, F. Pedicularis Limprichtii nom. nov. In Rep. Sp. Nov., 18: 122. 1822.

41. Fischer, F. E. L., and C. A. Meyer. Enumeratio plantarum novarum a cl. Schrenk lectarum. 2 v. 1841-42. (*Pedicularis* described by Schrenk, 1: 22. 1841; 2: 19-25. 1842.)

42. Forbes, F. B., and W. B. Hemsley. An Enumeration of all the plants known from China proper, Formosa, Hainan, Corea, the Luchu Archipelago, and the Island of Hongkong, together with their distribution and synonymy. In Journ. Linn. Soc. Bot., 23: 1-521. 1886-88; 26: 1-592, 1889-1902; 36: i-xi, 1-688. 1903-05. (*Pedicularis*, 26: 204-220. 1890.)

43. Franchet, A. Plantae Davidianae ex Sinarum Imperio. I. Plantes du Mongolie Chinoise. In Nouv. Arch. Mus. Hist. Nat. Paris, II, 5: 153-272. 1883; 6: 1-126. 1883; 7: 55-200. 1884. (*Pedicularis*, 6: 106. 1883.)

44. ———. Plantae Davidianae ex Sinarum Imperio. II. Plantes du Thibet Oriental (Province de Moupine). In Nouv. Arch. Mus. Hist. Nat. Paris, II, 8: 183-254. 1885; 10: 33-193. 1887-1888. (*Pedicularis*, 10: 66-68. 1888.)

45. ———. Sur quelques plantes rares ou nouvelles de la Flore du Nord de la Chine. In Morot, Journ. de Bot., 4: 317-320. 1890.

46. ———. Diagnoses d'espèces nouvelles provenant d'une collection de plantes du Thibet chinois envoyée au Muséum par M. l'abbé Soulié. In Bull. Soc. Philom. Paris, VIII, 3: 140-150. 1891.

47. ———. Les Scrophularinées de la Chine, dans l'herbier du Muséum de Paris. In Bull. Soc. Bot. France, 47: 10-37. 1900.

48. Gilmour, J. S. L. Pedicularis Delavayi. In Curtis's Bot. Mag., 157: *t. 9367*. 1934.

49. Handel-Mazzetti, H. Plantae novae sinenses, diagnosibus brevibus descriptae a Dre. Heinr. Handel-Mazzetti. In Anzeig. Akad. Wiss. Wien Math.-Nat. Kl., 57: 86-89, 102-105. 1920; 59: 245-256. 1922; 60: 95-101. 1923; 62: 234-242. 1925.

50. ———. Symbolae Sinicae. Botanische Ergebnisse der Expedition der Akademie der Wissenschaften in Wien nach Südwest-China, 1914-1918. 7 pts. 1929-37. (*Pedicularis*, 7: 849-871. 1936.)

51. Hemsley, W. B. Pedicularis vagans Hemsl. In Hook. Icon. Pl., 20: *t. 1978*. 1891.

52. Hooker, J. D. The flora of British India. 7 v. 1872-97. (*Pedicularis*, 4: 306-317. 1884.)

53. Hultén, E. Flora of Kamchatka and the adjacent islands. IV. Dicotyledonae, Pyrolaceae—Compositae. Svensk. Vet. Akad. Handl. III, 8 (2): 1-358, 6 pl. 1930. (*Pedicularis*, pp. 108-126.)

54. Kew, Royal Botanic Gardens, Staff of. Decades Kewenses. Plantarum novarum in Herbario Horti Regii Conservatarum. Decas V. In Kew Bull., 1893: 155-158. 1893. (Decas L. In op. cit., 1908: 249-255. 1908.

55. Komarov, V. L. Flora Manchuriae III. In Act. Hort. Petrop., 25: 1-853. 1907. (*Pedicularis*, pp. 447-459.)

56. Limpricht, W. Botanische Reisen in den Hochgebirgen Chinas und Ost-Tibets. In Rep. Sp. Nov., Beih. 12: i-viii, 1-515. 1922. ("II. Aufzählung der von Dr. Limpricht in Ostasien gesammelten Pflanzen", by Pax, F., pp. 298-515. 1922, *Pedicularis* identified by Limpricht, pp. 483-486.)

57. ———. Neue Pedicularis aus Ost-Tibet. I. In Rep. Sp. Nov., 18: 243-244. 1922.

58. ———. Studien über die Gattung Pedicularis. In Rep. Sp. Nov., 20: 161-265, 1 map. 1924.

59. ———. Nachträge zu Pedicularis. In Rep. Sp. Nov., 23: 333-339. 1927.

60. Linnaeus, C. Genera plantarum. 1737.

61. ————. Species plantarum. 2 v. 1753.

62. Marquand, C. V. B. The botanical collections made by Capt. F. Kingdon Ward in the eastern Himalaya and Tibet in 1924-25. In Journ. Linn. Soc. Bot., 48: 149-229. 1929. (*Pedicularis*, pp. 210-214.)

63. Maximowicz, C. J. Primitae florae Amurensis. In Mém. Acad. St. Pétersb. Sav. Etrang., 9: 1-504, pls. 1-10, 1 map. 1859. (*Pedicularis*, pp. 209-210.)

64. ————. Diagnoses plantarum novarum Asiaticarum. II. In Bull. Acad. Sci. St. Pétersb., 24: 26-89. 1878; in Mél. Biol. Acad. Sci. St. Pétersb., 10: 43-134. 1878. ("Pedicularis L. Species Asiae orientalis cum totius generis conspectu." 24: 51-89; 10: 84-134.)

65. ————. Diagnoses plantarum novarum Asiaticarum. IV. In Bull. Acad. Sci. St. Pétersb., 27: 425-560, pl. 1. 1882; in Mél. Biol. Acad. Sci. St. Pétersb., 11: 155-350, pl. 1. 1882-83. ("Addenda et emendanda ad Pedicularium conspectum." 27: 510-521; 11: 278-294.)

66. ————. Diagnoses plantarum novarum Asiaticarum. VII. In Bull. Acad. Sci. St. Pétersb., 32: 477-629, pls. 1-7. 1888; in Mél. Biol. Acad. Sci. St. Pétersb., 12: 713-934, pls. 1-7. 1888. ("Pedicularis L. Synopsis generis nova." 32: 515-619, pls. 1-7; 12: 769-919, pls. 1-7.)

67. Ostenfeld, C. H., and O. Paulsen. A list of flowering plants from inner Asia, collected by Dr. Sven Hedin, determined by various authors and compiled by C. H. Ostenfeld and O. Paulsen. In Sven Hedin, Southern Tibet: Discoveries in former times compared with my own researches 1906-1908, 6 (3): 25-100. *t. 1-8.* 1922.

68. Osten-Sacken, F. von, and J. F. Ruprecht. Sertum Tianschanicum. Botanische Ergebnisse einer Reise in Mittleren Tian-Schan. In Mém. Acad. Sci. St. Pétersb. VII, 14 (4): 1-74. 1869.

69. Pai, Yin-Yuan. Notes on some Pedicularis from Kirin. In Contr. Inst. Bot. Nat. Acad. Peiping, 2: 125-132, 1 pl. 1934.

70. ————. Preliminary notes on Scrophulariaceae in China. In Contr. Inst. Bot. Nat. Acad. Peiping, 2: 181-226. 1934. (*Pedicularis*, pp. 208-224.)

71. Palabin, J. W. Plantae Sinico-Mongolicae in itinere Chinganensi anno 1891 collectae. In Act. Hort. Petrop., 14: 103-145. 1895. (*Pedicularis*, pp. 134-135.)

72. Pallas, P. S. Reise durch verschiedene Provinzen des russischen Reiches. 3 v. 1771-76. (*Pedicularis*, 3: 737-738. 1776.)

73. Pennell, F. W. The Scrophulariaceae of the western Himalayas. In Monogr. Acad. Nat. Sci. Phila., 5: i-vii, 1-163. pls. 1-25. 1943. (*Pedicularis*, pp. 113-156.)

74. Prain, D. Noviciae Indicae. I. Some additional species of Pedicularis. In Journ. Asiat. Soc. Bengal, 58 (2): 255-278. 1889.

75. ————. The species of Pedicularis of the Indian Empire and its frontiers. In Ann. Roy. Bot. Gard. Calcutta, 3: 1-196, pls. 1-37, 1 map. 1890.

76. ————. Pedicularis cranolopha, Maxim. In Hook. Icon. Pl., 23: pl. 2208.

77. ————. Pedicularis rhynchodonta, Bur. et Franch. In Hook. Icon. Pl., 23: pl. 2209. 1892.

78. ————. Pedicularis Hemsleyana, Prain. In Hook. Ic. Pl., 23: pl. 2210. 1892.

79. ————. Two species of Pedicularis. In Journ. Asiat. Soc. Bengal, 62 (2): 7-9, pls. 1-2. 1893.

80. Regel, E. Descriptiones plantarum novarum et minus cognitarum. Fasciculus VII. In Act. Hort. Petrop., 6: 287-403. 1879.

81. Regel, E., and F. von Heder. Enumeratio plantarum in regionibus cis-et transiliensibus a cl. Semenovio 1857 collectarum. In Bull. Soc. Nat. Moscou, 41 (1): 59-113. 1868.

82. Rehder, A., and C. E. Kobuski. An enumeration of the herbaceous plants collected by J. F. Rock for the Arnold Arboretum. In Journ, Arnold Arb., 14: 1-52. 1933. (Determined at the Botanic Museum, Berlin-Dahlem, *Pedicularis* pp. 32-35.)

83. Schrenk, L. Species plantarum novae, a D. Al. Schrenk nuperime in Songaria lectae. In Bull. Phys. Math. Acad. Sci. St. Pétersb., 1: 79-80. 1842.

84. Smith, W. W. The alpine and sub-alpine vegetation of south-east Sikkim. Rec. Bot. Surv. India, 4: 323-431. 1913. (*Pedicularis* identified by G. Bonati, pp. 400-403.)

85. Smith, W. W., and G. H. Cave. The vegetation of the Zumu and Llonakh valleys of Sikkim. Rec. Bot. Surv. India, 4: 141-260. 1913. (*Pedicularis* identified by G. Bonati, pp. 228-230.)

86. Steven, C. Monographia Pedicularis. In Mém. Soc. Nat. Moscou, 6: 1-60, pls. 1-17. 1823.

87. Walker, E. H. Plants collected by R. C. Ching in southern Mongolia and Kansu province, China. In Contr. U. S. Nat. Herb., 28: 563-675. 1941. (*Pedicularis*, pp. 659-660, based on the determinations made by G. Bonati.)

88. Wallich, N. A numerical list of dried specimens of plants in the East India Company's Museum, collected under the superintendence of Dr. Wallich of the company's Botanic Garden at Calcutta. 1-306. 1828-49.

89. Willdenow, C. L. Species Plantarum. 6 v. 1797-1830. (*Pedicularis*, 3: 202-221. 1800.)

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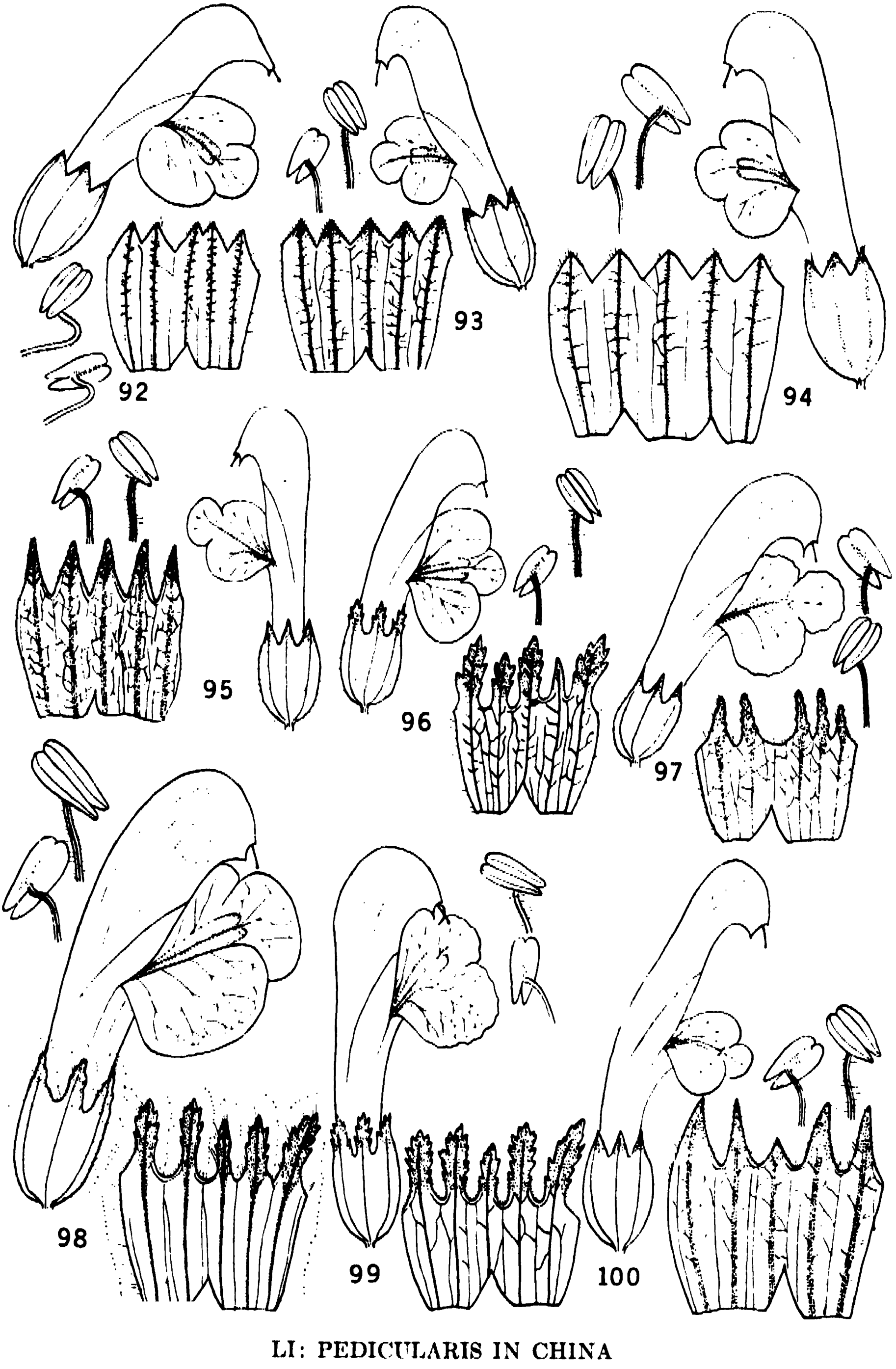

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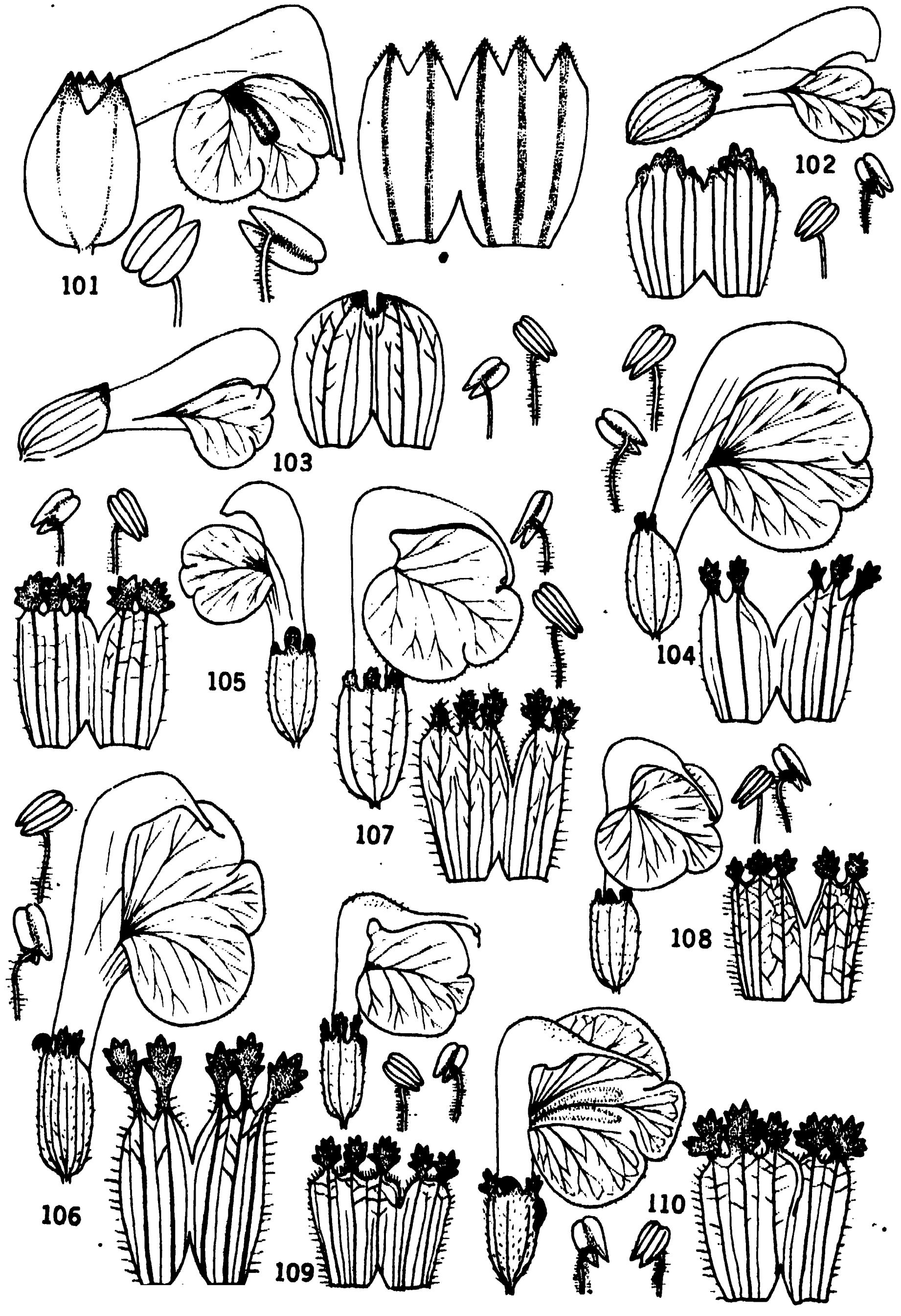

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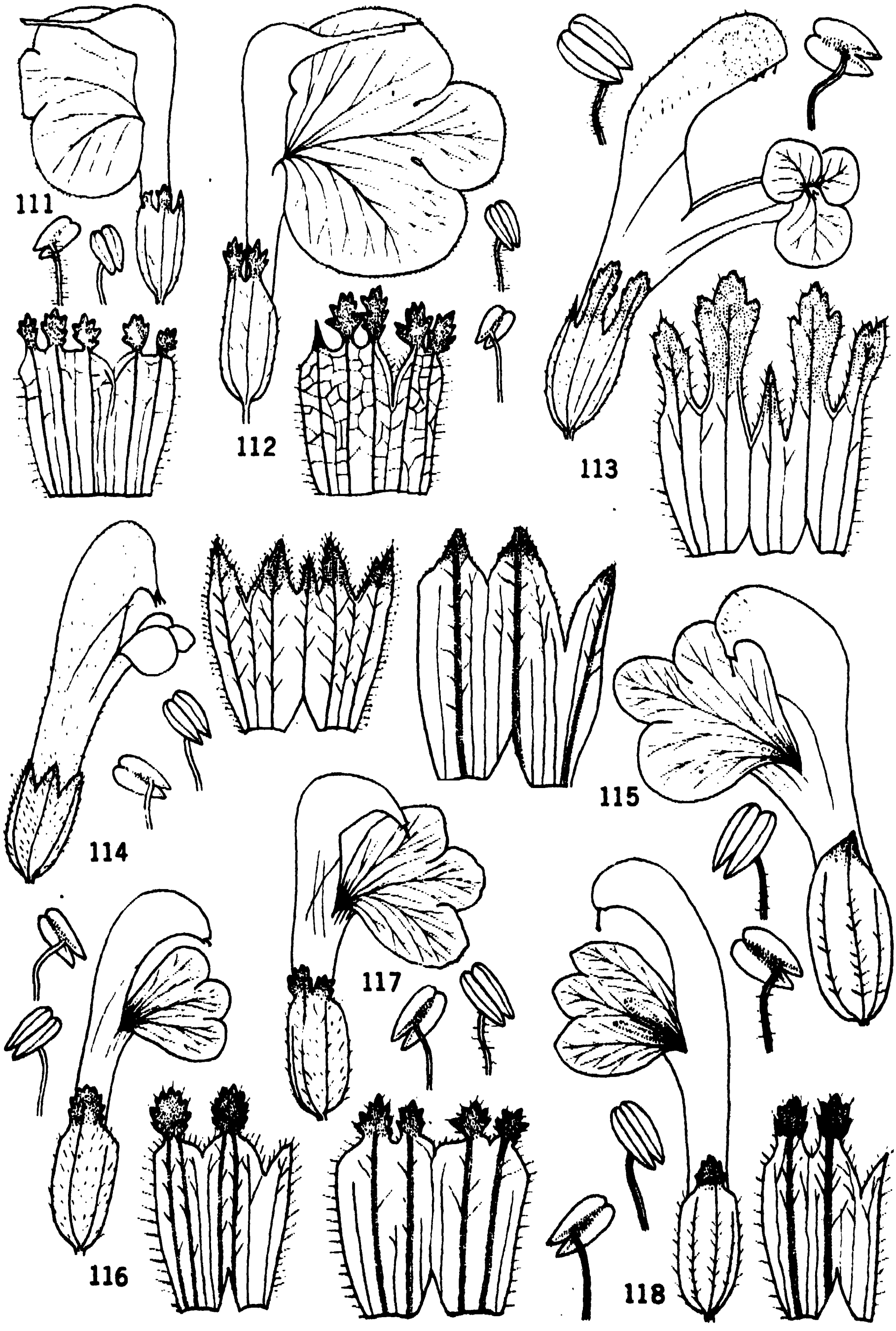

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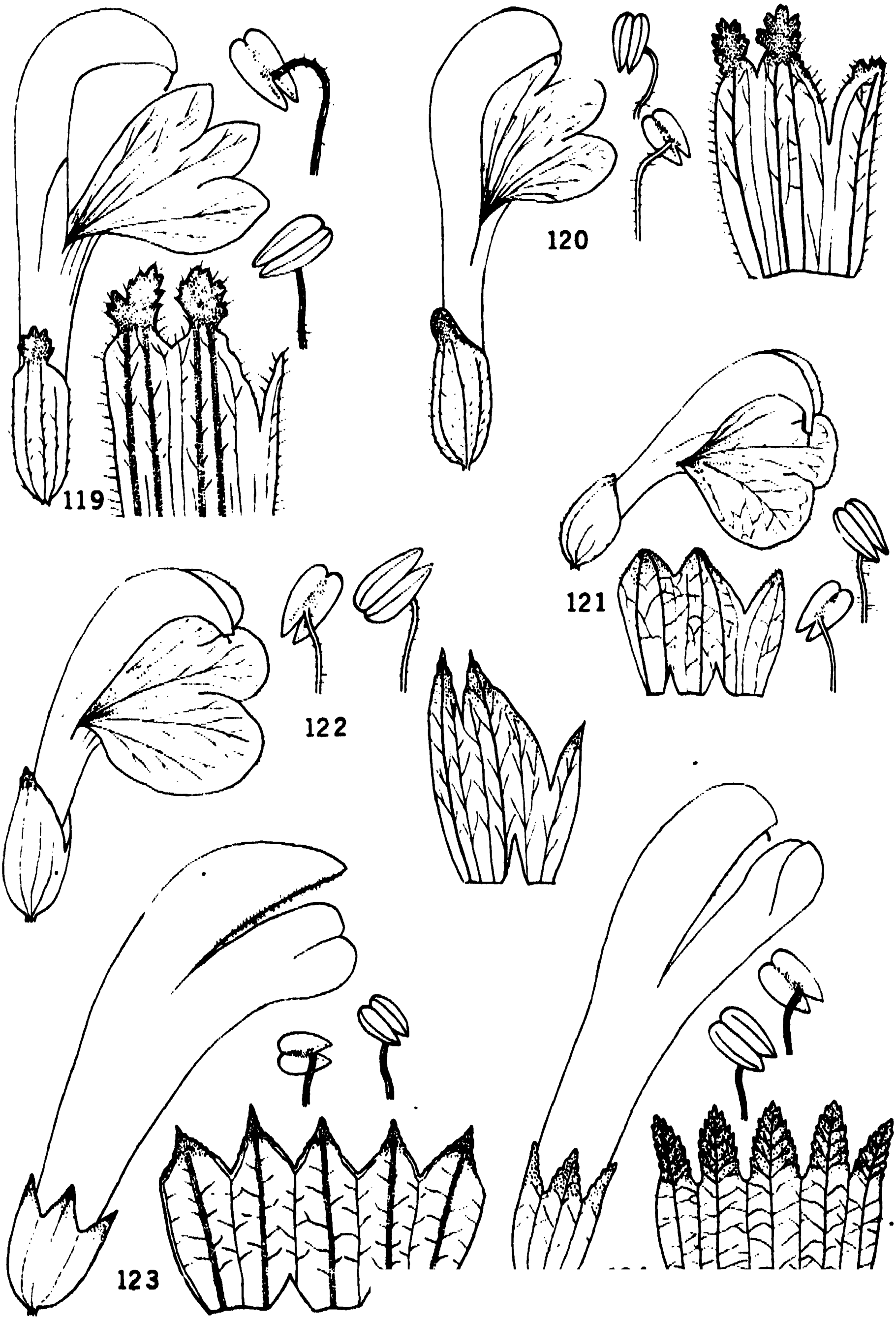

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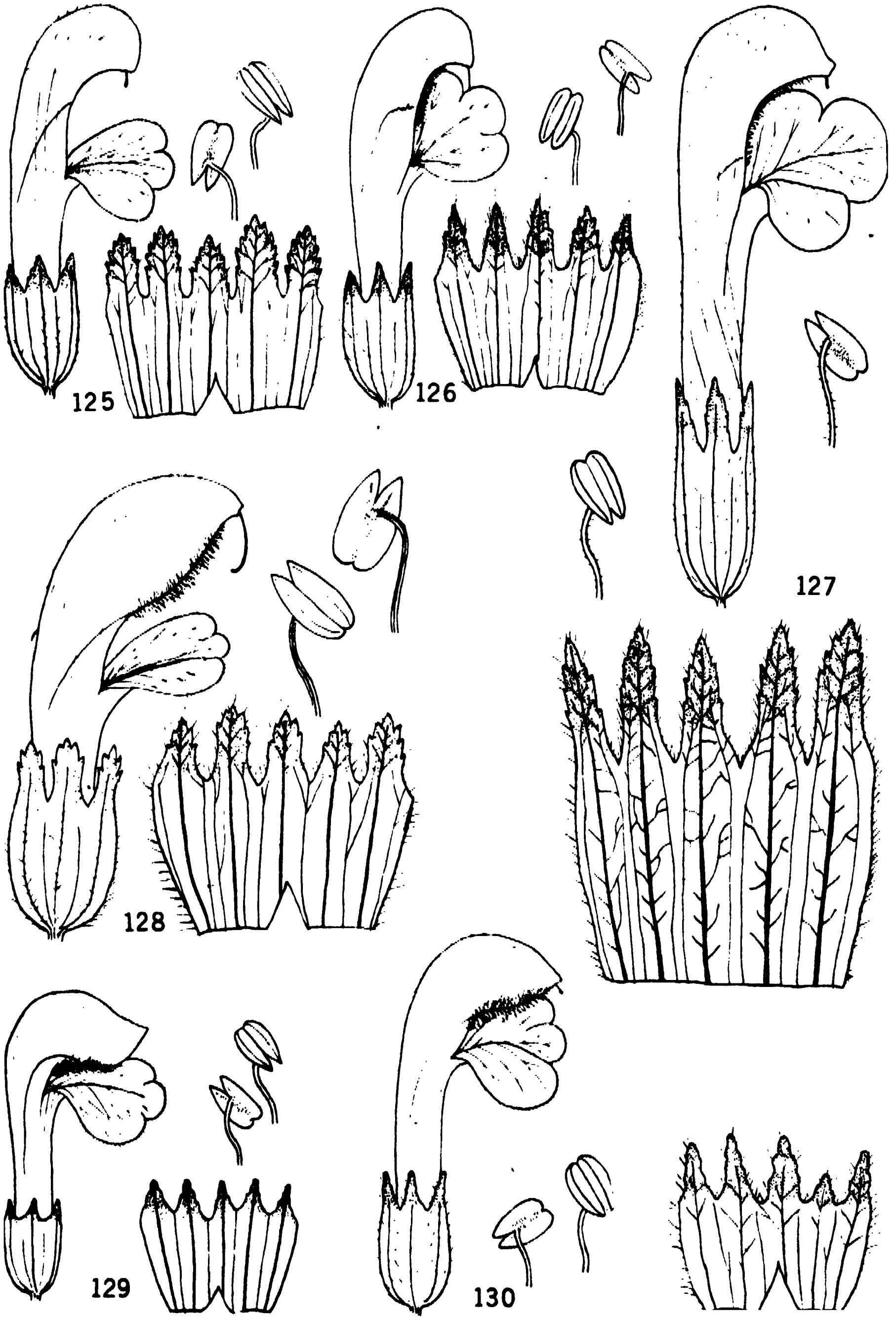

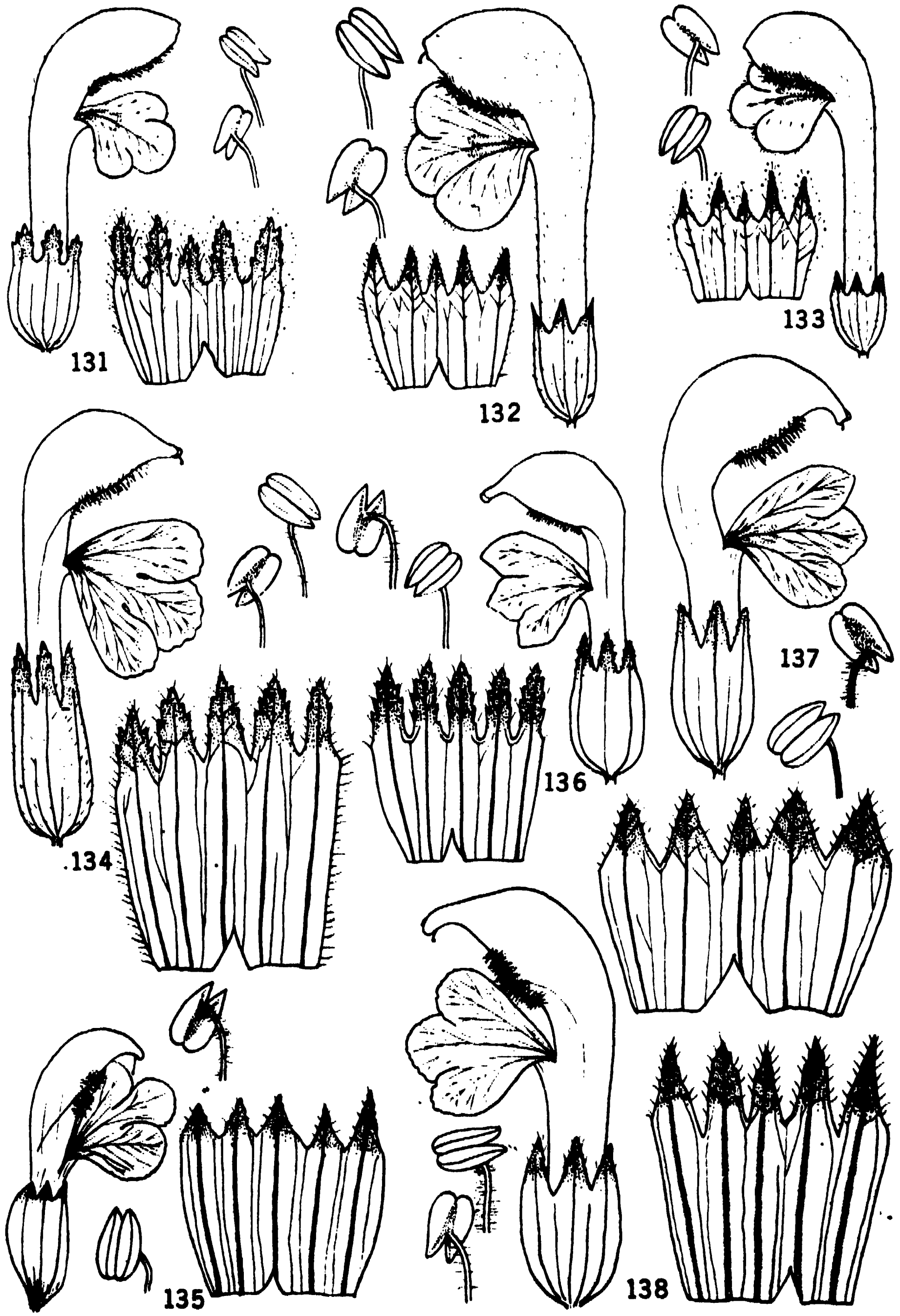

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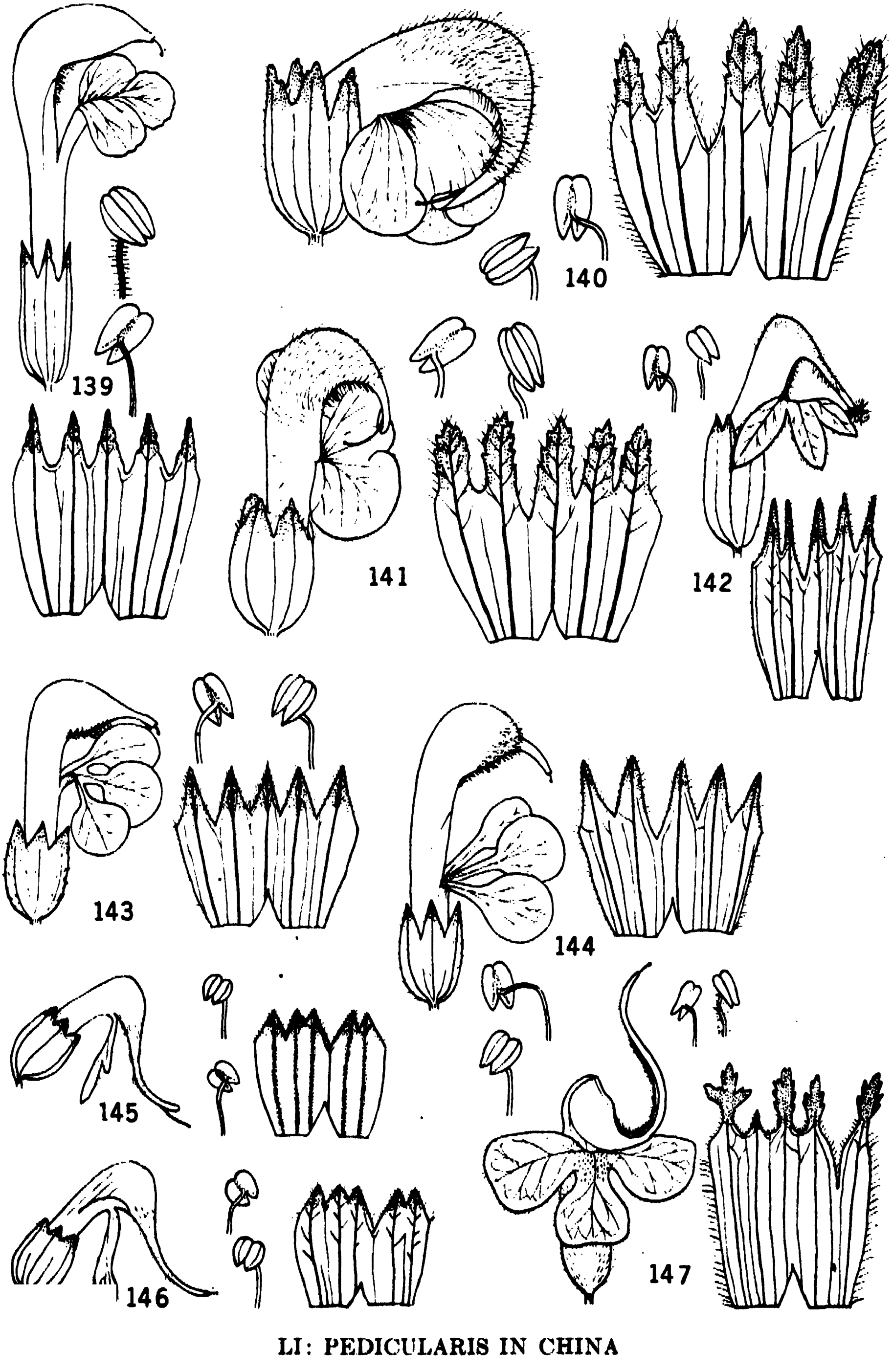

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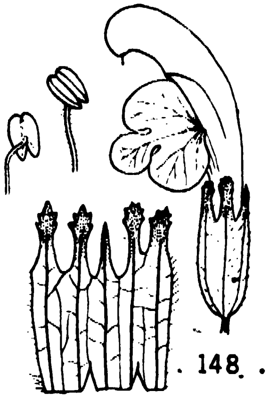
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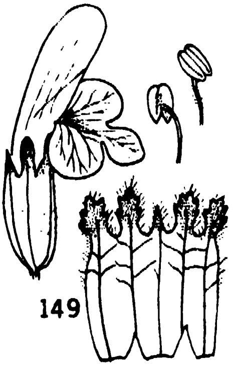
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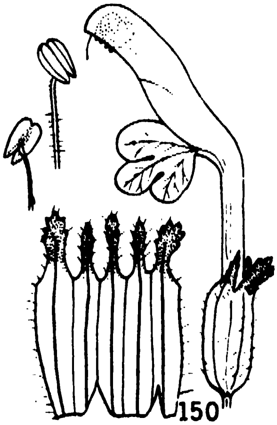
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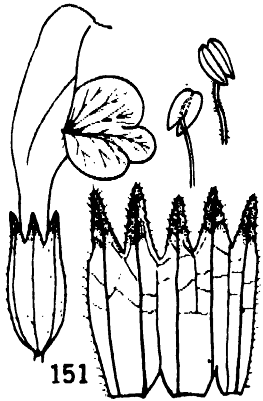
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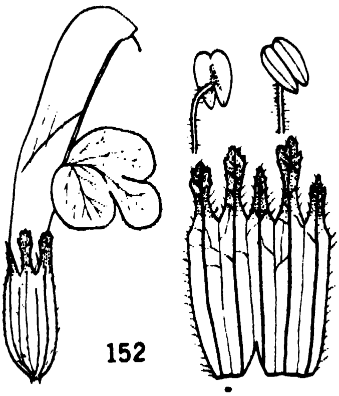
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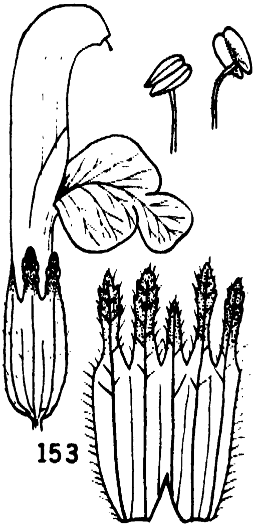
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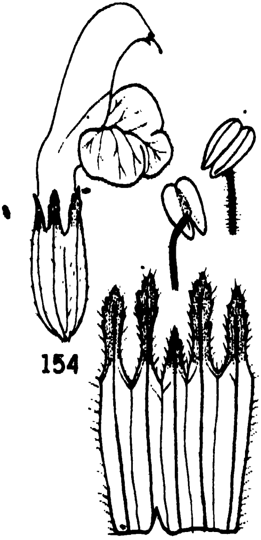
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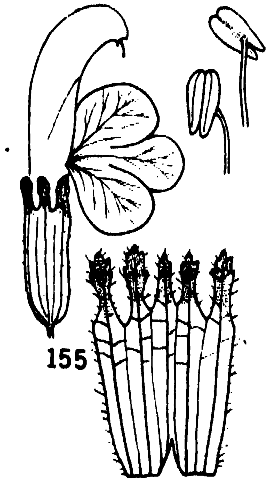
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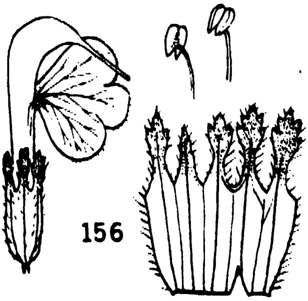
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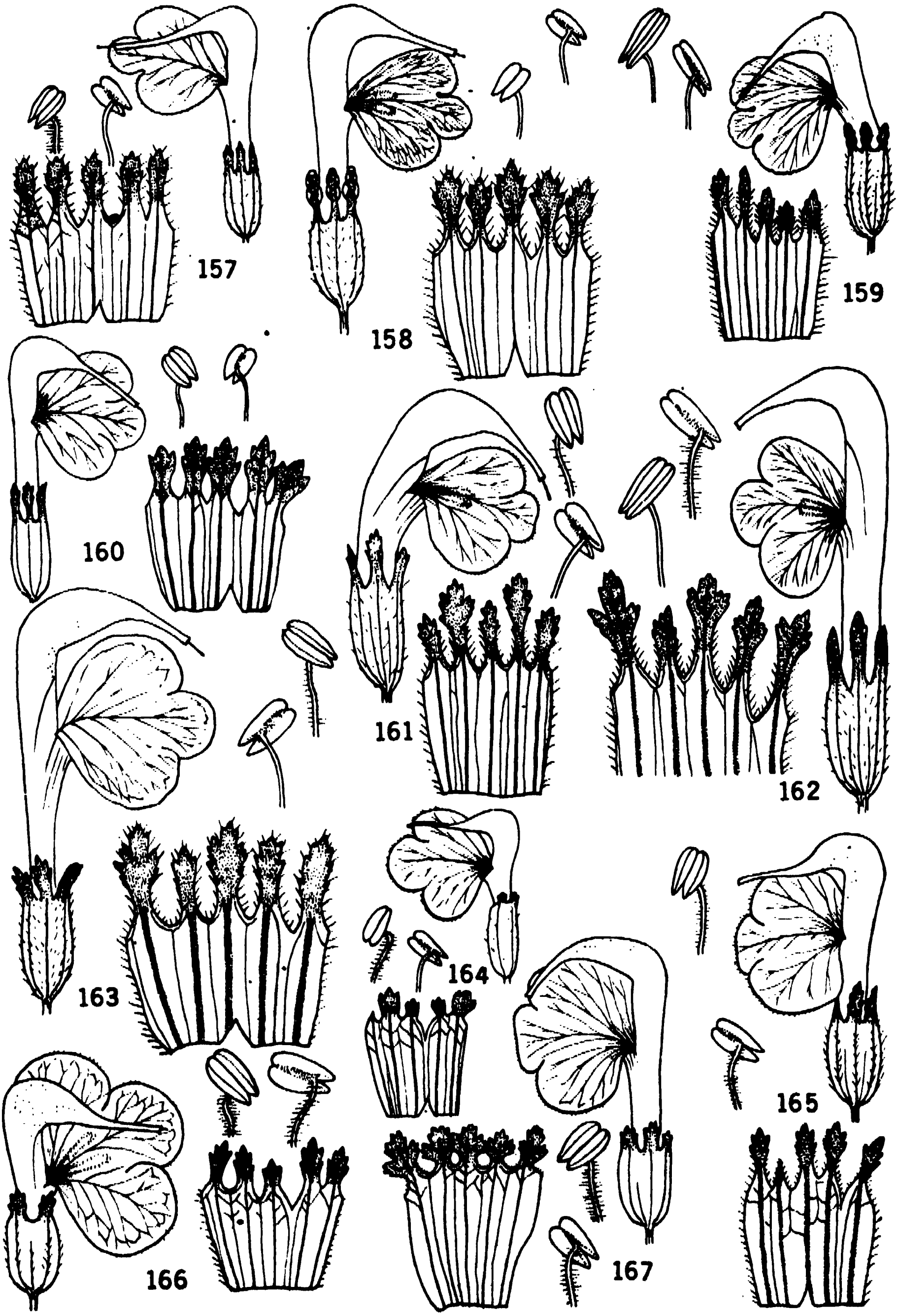

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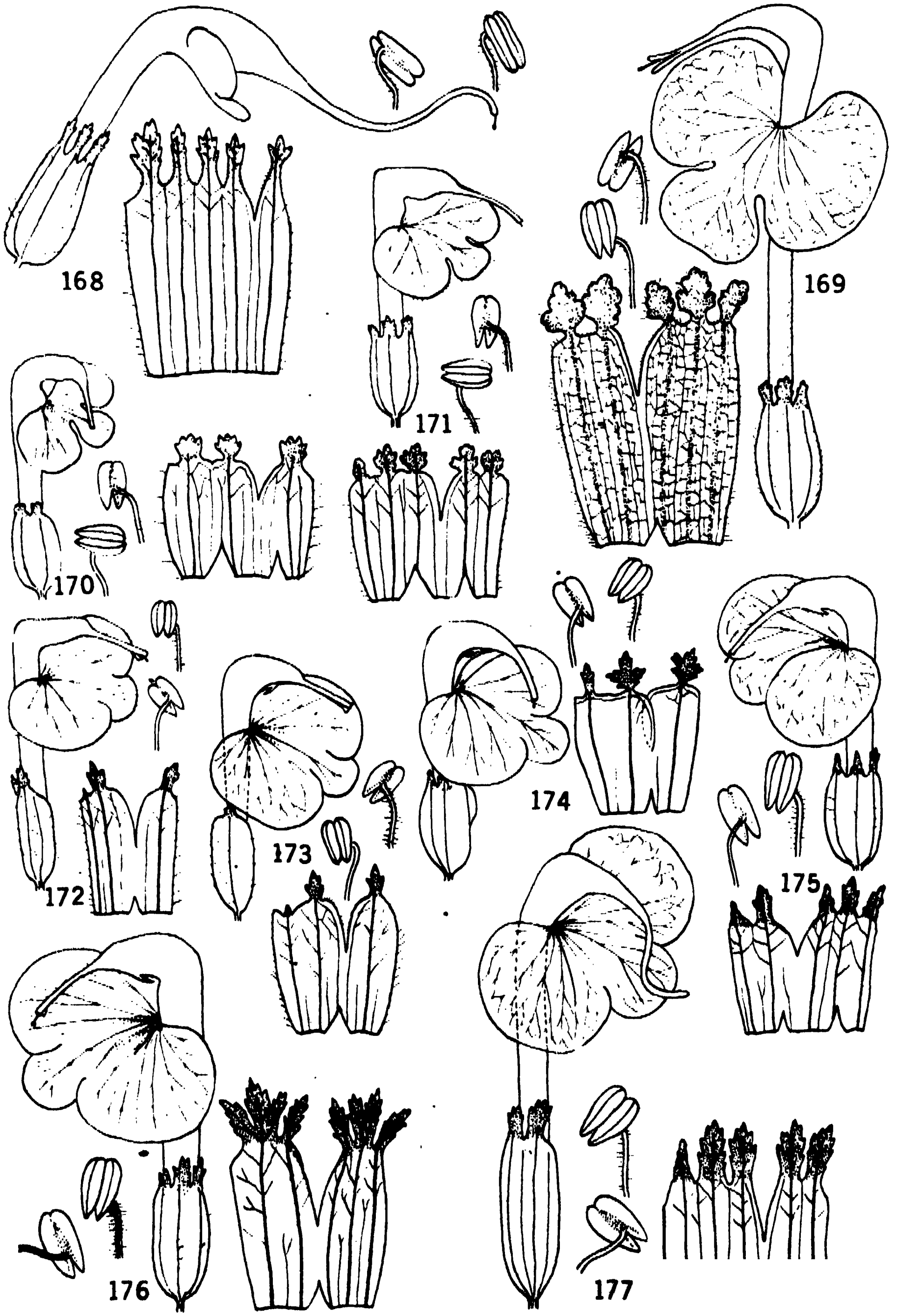

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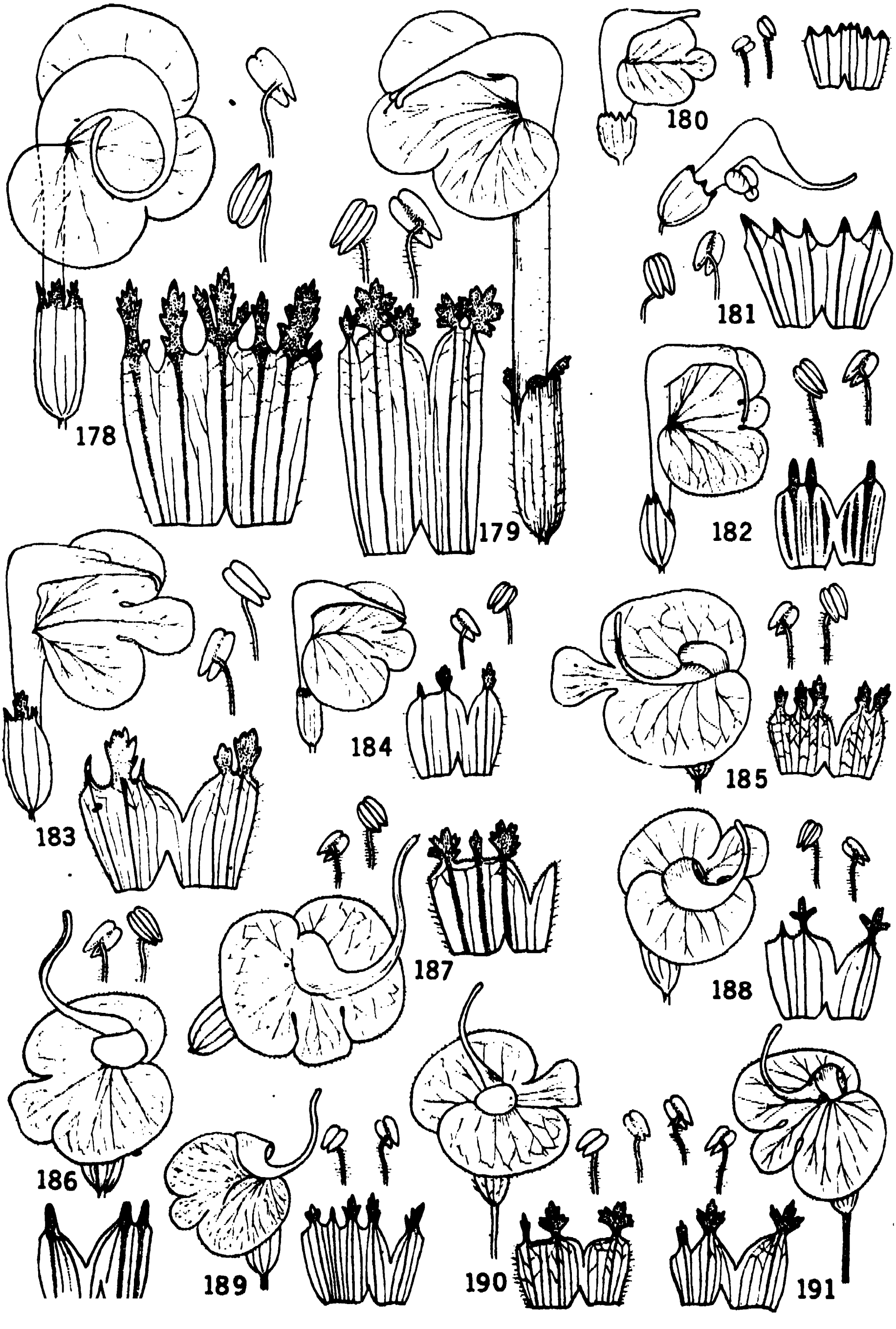

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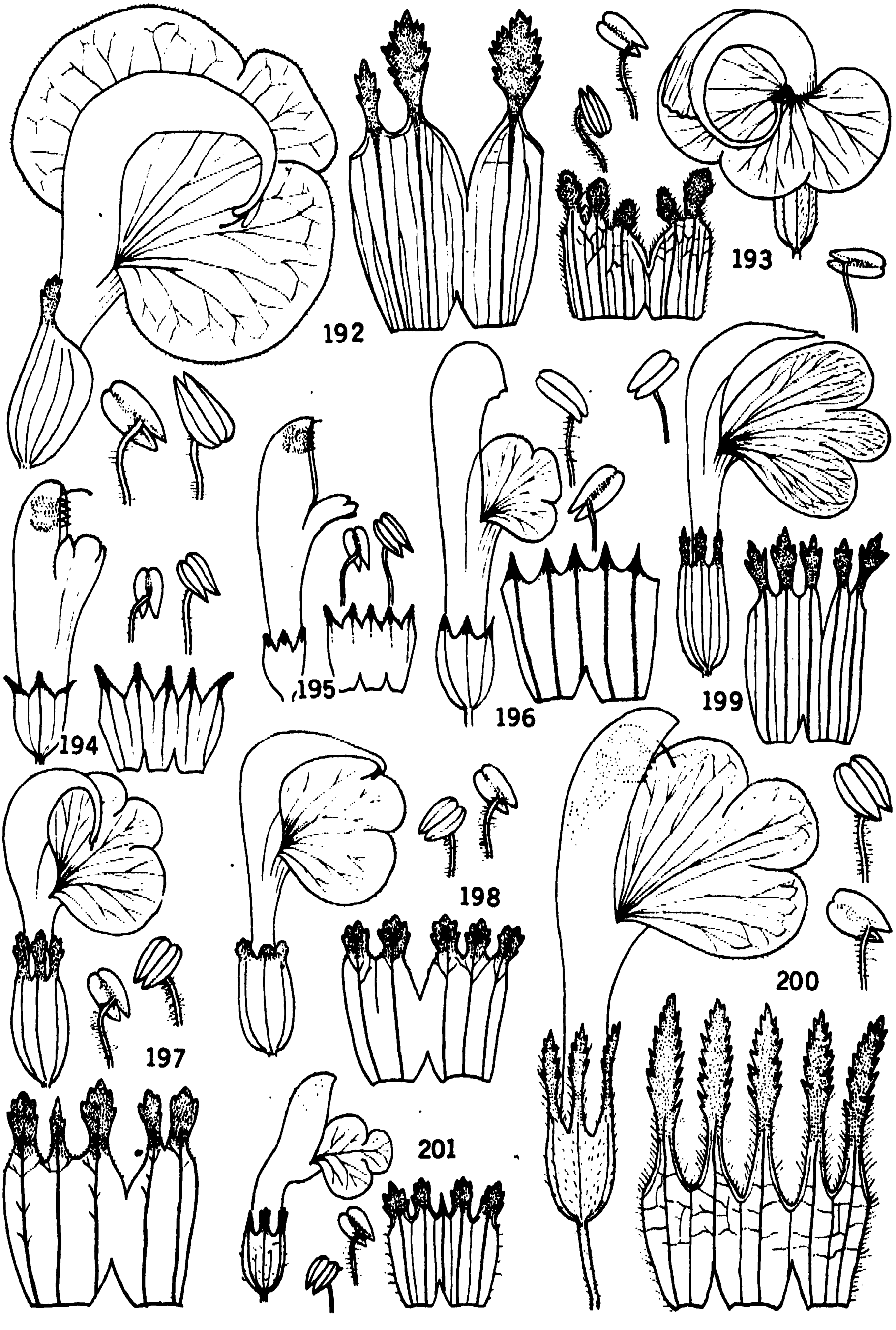

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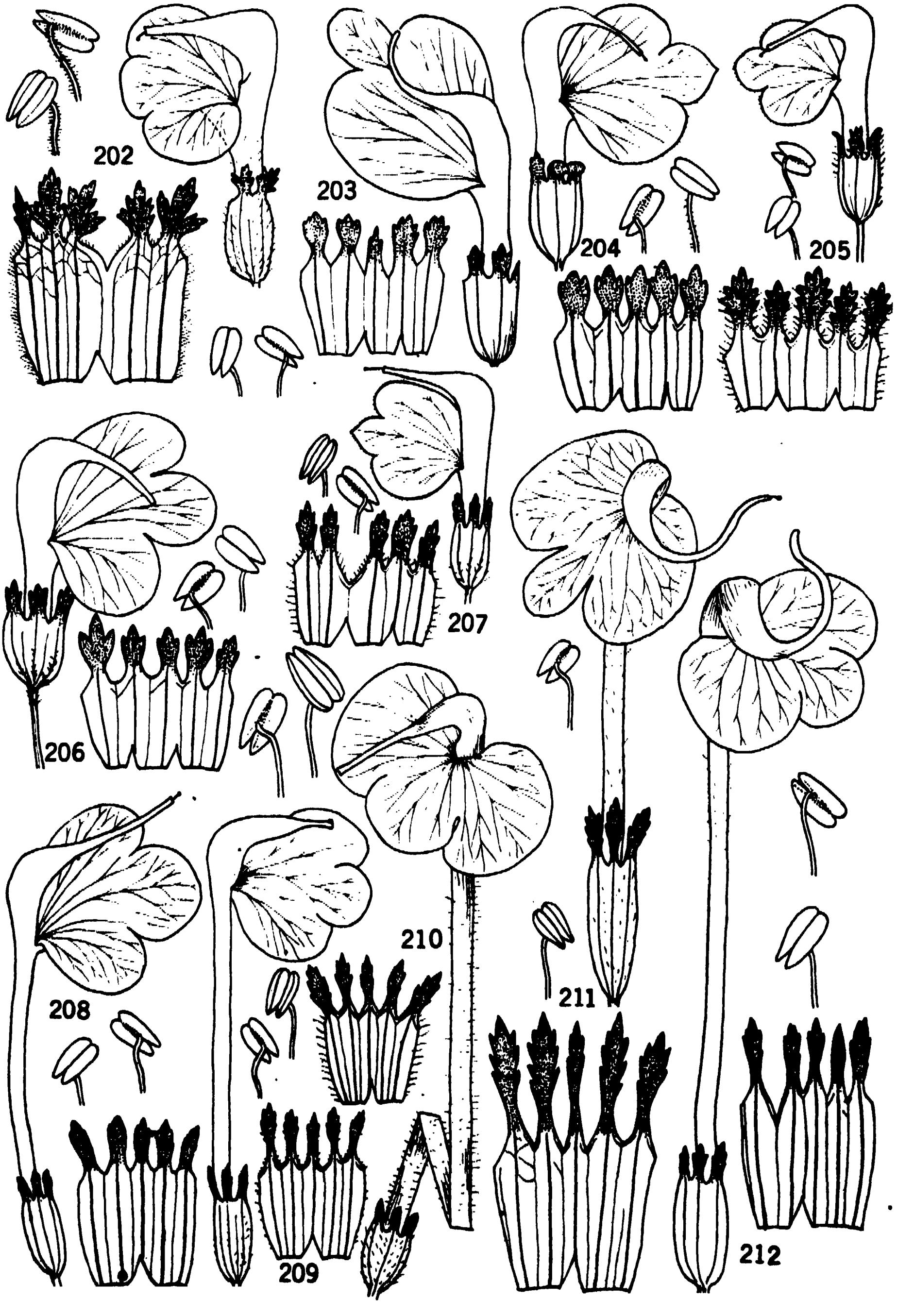

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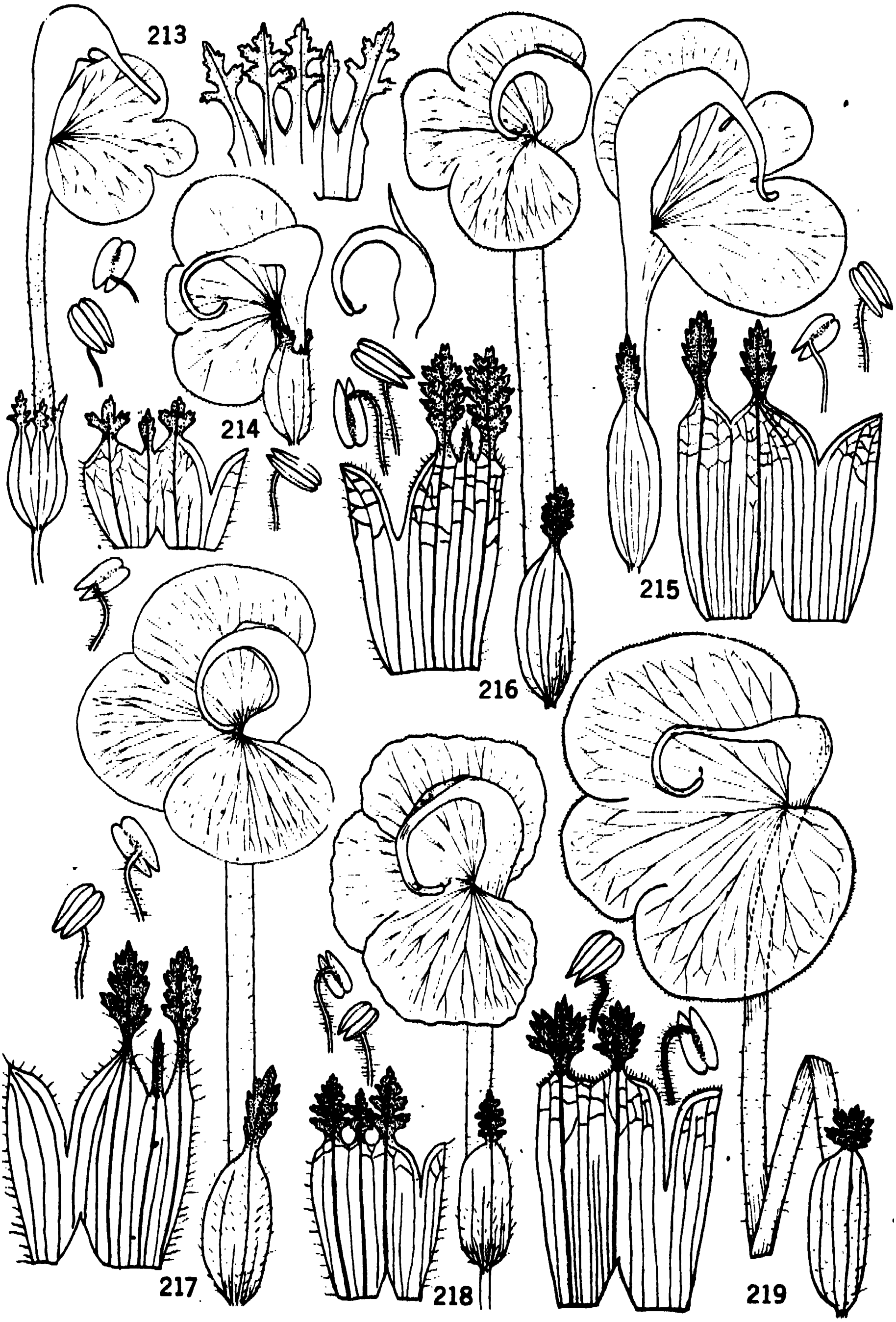

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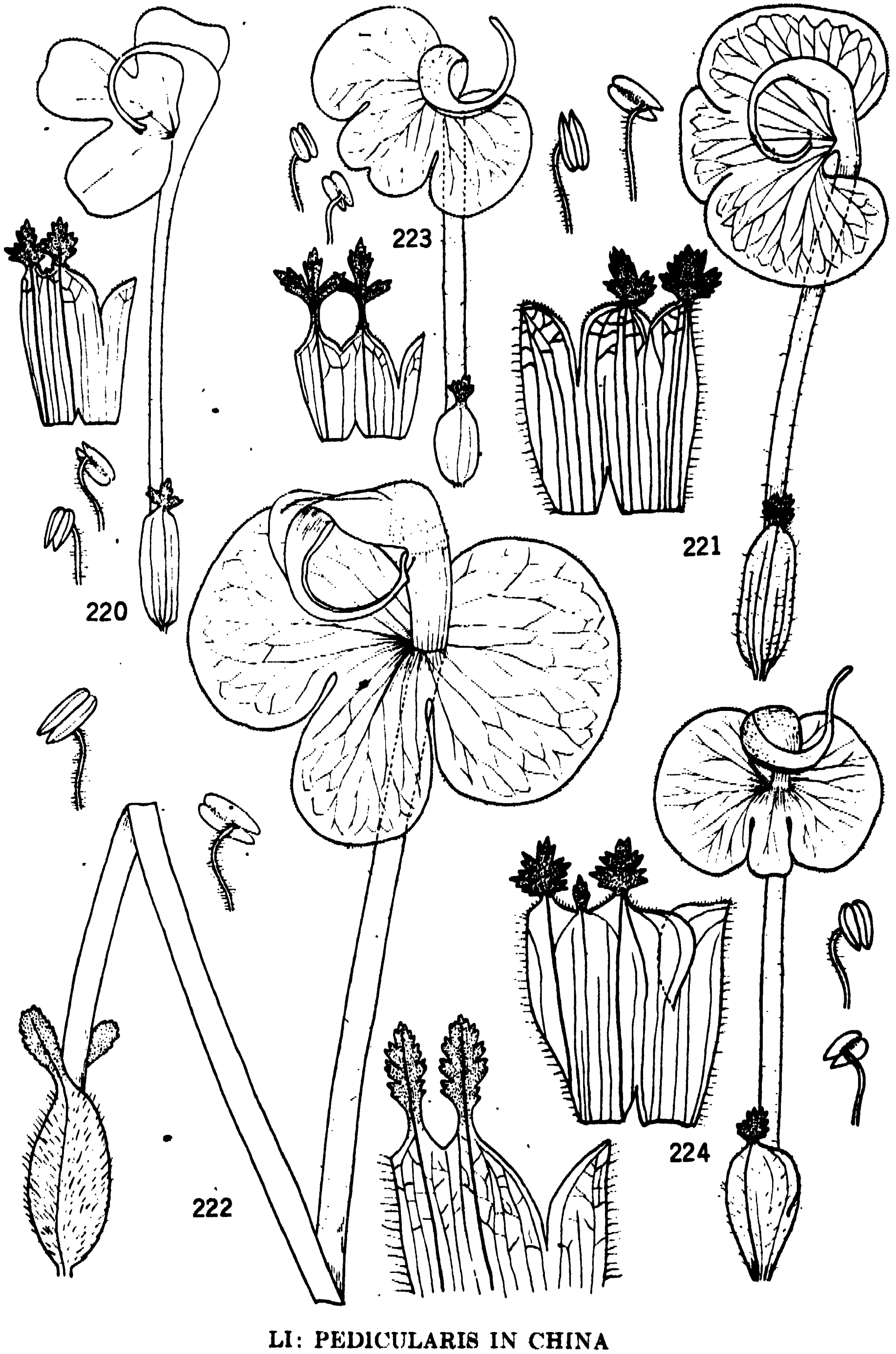

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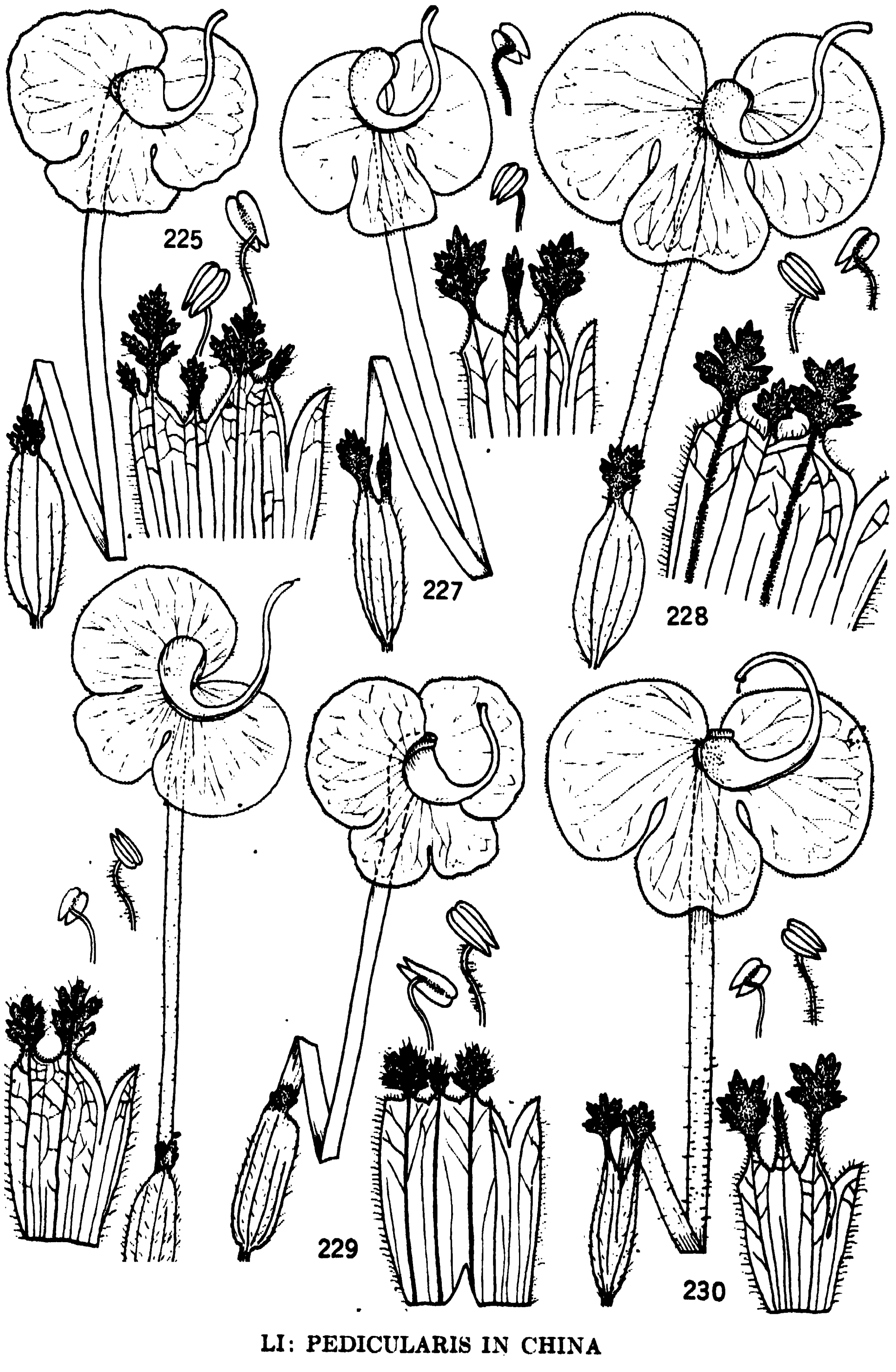

LI: PEDICULARIS IN CHINA

PERUVIAN LAND MOLLUSKS OF THE GENUS NENIA (CLAUSILIIDAE)

BY HENRY A. PILSBRY

Curator of Mollusks, The Academy of Natural Sciences of Philadelphia

Of about 52 species of Clausiliidae known from Peru, five belonging to the genus *Temesa* have been considered in a former paper.[1] Preliminary to a general review of the others, several species collected by Dr. W. Weyrauch, Dr. Axel A. Olsson and the author are described here, together with notes on some of the older species.

No definite localities in Peru were given for a considerable number of species, a number have not been figured, and part of the older species were inadequately described. These deficiencies often make the identification of new material difficult.

Among the species here described as new, *Nenia callistoglypta* is remarkable by having both sinistral and dextral forms, and *N. polinskiana* is the second Peruvian species in which palatal armature and clausilium are absent.

A grant in aid for travelling expenses in Peru, from the American Philosophical Society, is gratefully acknowledged.

INCAGLAIA new subgenus

The slender shell is sculptured with strong, irregular wrinkles which are sinuous, angularly bent or interrupted. The inferior lamella is receding, inconspicuous in face view. The clausilium tapers anteriorly, is calloused along the columellar side and projects in a prominent point at the end. Type *N. olssoni* new species.

(Inca + ἀγλαΐα, beauty.)

Nenia olssoni new species Plate 17, figs. 3-3c.

The shell is entire, very slenderly fusiform, but usually the penult and next earlier whorls are of about equal diameter; white with a deep brown or black summit. Whorls of the upper half are strongly convex, the convexity then diminishing, the last whorl flat-sided, tapering downward, becoming free in front and descending to the aperture. First 1½ whorls are smooth and glossy; later whorls have sculpture of very irregular, strong, white wrinkles, sinuous or angularly bent, or often interrupted, on a dark ground having some incomplete white striae as in fig. 3b. On the last half of the last whorl this wrinkle sculpture gives place to fine, white, axial striae, and long granules.

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[1] Notulae Naturae, Acad. Nat. Sci. Phila., no. 214.

The aperture is broadly piriform, dark brown within, fading at the edge of the peristome, which is well expanded on the columellar side, narrow at the outer and basal margins. The superior lamella is thin but rather strong, continuous with the spiral lamella. Inferior lamella receding, rather low (or sometimes not visible in a direct face view); strongly spiral and broad within the back. Subcolumellar lamella thin and high, immersed, as usual. The principal plica is strong but short. There is a strongly arcuate lunella, which is low, almost interrupted near the recurved upper end, which thus appears like an upper palatal plica.

The clausilium (fig. 3) is wide above, tapering rapidly to the end, heavily calloused along the columellar margin, the callus projecting in a prominent point at the anterior end; the palatal margin is strongly convex, the columellar margin excised near the filament.

Length 13.7 mm., diameter 2.6 mm. 10 whorls. Type, figs. 3a, b, e.
Length 11.5 mm., diameter 2.7 mm. 8½ whorls.
Length 11.1 mm., diameter 2.3 mm. 9 whorls.

Between Anco and Huanta, valley of Rio Montaro, on the road from Mejorada, on Jurassic limestone. Type and figured paratypes 185176 ANSP., collected by Dr. Axel A. Olsson.

This lovely little *Nenia* is somewhat like *N. callistoglypta*, but smaller, and in that species the prominences of the sculpture are strongly striate. The clausilium of *N. olssoni* is peculiar to that species.

Subgenus Uncertain

Where this species belongs in the series is not clear to me.

Nenia callistoglypta new species Plate 17, figs. 2, 2a-2c.

The shell is sinistral (see below), entire, rather thin, slenderly fusiform-turrited. The upper half tapering and somewhat attenuated near the summit; whorls rather weakly convex, the last whorl narrower, more or less flattened laterally, becoming free and descending, the back either rounded or varying to indistinctly or distinctly subangular. The color is very pale fleshy brown or nearly white. The initial 1½ whorls are convex and glossy, but otherwise the surface is matt with sculpture of irregular, coarse low wrinkles the summits of which are cut into strong opaque white axial striae; the intervals between wrinkles being smoothish, with traces of much finer or only obsolete striation.

The aperture is white within, the peristome thin, broadly expanded and subreflexed, white, the upper margin straightened, the outer margin less arcuate than the columellar margin. The superior lamella is rather high, thin, somewhat concave towards the sinulus, and emerges to the lip edge; inwardly passing into a long high spiral lamella which does not enter as far as the inferior lamella. The inferior lamella is deeply placed, and only a small part or none is visible in a direct face view. It emerges only to the inner edge of the lip expansion. Internally it is not much curved spirally. The subcolumellar lamella though strong is very deeply immersed, not visible in the aperture, and terminates near the lower end of the lunella, with which a weak callus connects it. The strong principal plica runs from a dorsal position nearly to the inner margin of the lip expansion and is visible deep in the sinulus. The lunella is low, rather weakly curved, and is recurved above like a short upper palatal plica.

The clausilium (fig. 2c) tapers to the filament, is strongly curved lengthwise and moderately curved transversely, the distal end is slightly oblique, blunt (somewhat foreshortened in the figure), very slightly thickened.

Length 18.5 mm., diameter 3.3 mm.; 11 whorls.
Length 16.3 mm., diameter 3.3 mm.; 10½ whorls.

Mejorada (Rio Montaro), near Huancayo. Type and paratypes 184059 ANSP., from No. 600 of Dr. Weyrauch's collection.

The elaborate sculpture is a prominent characteristic of this species. The degree of immersion of the inferior lamella is quite variable individually.

Form *dextroversa* new form (Pl. 17, figs. 1, 1a). With the sinistral form described above there were some dextral specimens, like the others in sculpture, but the shape is slightly more widely fusiform, and they have about one whorl fewer. Three specimens measure:

Length 17.2 mm., diameter 4.5 mm.; 9½ whorls.
Length 16.2 mm., diameter 4.0 mm.; 9⅓ whorls.
Length 17.3 mm., diameter 4.0 mm.; 9½ whorls.

It appears that in this species the coil may be either sinistral or dextral, for the specimens occurred together, and they seem to me too much alike to permit the idea that there are two species.

The disputed question of whether there are amphidrome species of Clausiliidae was discussed not long ago by Lajos Soós[2] in treating of the genus *Alopia*. It appears that both dextral and sinistral forms occur, which are otherwise almost or quite completely alike. According to the data he had, " mixed colonies never occur "; each population is either purely dextral or wholly sinistral. Soós therefore concluded that dextral and sinistral *Alopiae* are separate species.

Subgenus COLUMBINIA Polinski

Columbinia Polinski, 1925, Bull. Acad. Polon. Sci. Lettr., 1924, ser. B, p. 743. Type *N. columbiana* Pol.

These are entire, fusiform shells with inconspicuous sculpture, a rather long neck which is rounded basally, and a short aperture, the inferior lamella receding. The species are distributed from Colombia to Peru.

The group of Peru and Bolivia containing *N. bartletti*, *N. juninensis*, *N. binkiae* and others, appears related to *Columbinia* and to *Incania*, without agreeing fully with either. For want of any better place they are left here.

Nenia atracta new species Plate 18, figs. 2-2c.

The shell is entire, rather slenderly fusiform, solid, of uniform very pale brown color. The whorls are rather strongly convex, the suture deeply inpressed, the last whorl compressed, tapering downward, rounded basally, deeply grooved above the aperture by the suture; it descends steeply and is built forward to the aperture. The surface is somewhat shiny, strongly and regularly costulate, the riblets narrow, straight, strongly oblique, about 4 in 1 mm. on face of the last whorl, scarcely closer on the free part.

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[2] Annales Musei Nationalis Hungarici, 25: 379-385. 1928.

The aperture is shortly ovate, its short axis about 77 per cent of the longest axis, the upper margin straightened; it is slightly oblique, wider than long, brown within. Peristome is broadly expanded and reflected, somewhat thickened within, pale at the edge. The superior lamella is marginal, vertical, concave on the left side, continuous within with the spiral lamella. The inferior lamella is low, receding, and not visible in direct front view. Subcolumellar lamella not visible in the mouth. The dorsal principal plica is only about one-fourth of a whorl long. Lunella rather strongly curved, white, so far within that only part of it is visible in an oblique view in the aperture.

The clausilium (fig. 2c, inner and outer views) is broad, strongly curved lengthwise but not strongly so transversely. The columellar margin is strongly convex in the lower half, straightened above; the palatal margin more evenly convex, the spatula tapering near the end, which is a little thickened within.

Length 15.3 mm., diameter 3.4 mm.; length of aperture, measured parallel to axis, 2.8 mm., width 3 mm.; 8½ whorls.

Cerro Azul, Department of Loreto (near Cantamaná). Type 185111 ANSP., from No. 573 of Dr. W. Weyrauch's collection.

This species is nearly related to *Nenia bryantwalkeri* Pils. (Nautilus, 35: 95, 1922), but is somewhat more slender and the shape of the aperture is quite different, that of *bryantwalkeri* being distinctly longer than wide. The clausilium of *N. bryantwalkeri* is relatively narrower, and at the end it is more oblique and more thickened than that of *atracta.*

N. atracta is smaller and more fusiform than *N. sublutea,* with shorter, more convex whorls and stronger riblets.

Nenia gracilis new species Plate 18, figs. 4, 4a, 4b.

The shell is entire, slender and fusiform, the diameter about one-fifth of the length, the apex small but obtuse. The whorls are moderately convex, the suture well impressed and decidedly oblique. The last whorl is compressed laterally, and rounded at base; it descends steeply and is built forward to the aperture. The color is uniform light brown (like a very dilute snuff brown). Surface somewhat shining, and after about 1½ smooth whorls it has fine sculpture of very oblique, straight riblets, about half as wide as their intervals; on the face of the last whorl there are six or seven riblets in one mm., on the penult whorl five or six, the riblets being slightly finer and closer on the back of the last whorl.

The aperture is nearly as wide as long, rounded but with straightened upper and left margins, purplish brown within, its plane oblique. Peristome thin, broadly expanded and reflected throughout, a little retracted at the rather wide sinulus, the edge whitish. Superior lamella is marginal, thin, vertical, continuous within with the spiral lamella. The inferior lamella is low and receding, only a small part visible in a direct front view. Subcolumellar lamella is deeply immersed, its white end conspicuous in an oblique view in the mouth. The principal plica is parallel to the suture, about one-third of a whorl long. The lunella is obsolete except for a short, oblique upper portion, and is dorsal in position.

The clausilium (fig. 4b) is moderately curved lengthwise but not much transversely, the columellar side rather strongly convex, palatal side straightened. It tapers gradually to the narrow end, where it is rather strongly thickened.

Length 20.3 mm., diameter 4.2 mm.; length of aperture measured parallel to the shell axis, 4.2 mm., width 4.2 mm.; 8½ whorls.

Divisoria, Cordillera Azul, 1500 m. (northeast of Tingo Maria). Type 185112 ANSP., from 567 of Dr. Weyrauch's collection.

This snail, like the preceding species, has the characters of Polinski's subgenus *Columbinia*. It appears to be nearly related to *N. adamsiana* (Pfeiffer) of unknown locality, but that is a more finely striate, stronger, wider shell, " testa solidula, spira medio subinflata ".

At first I thought this snail was a form of *N. sublutea* Bttg., but that species differs in shape of the aperture, which was described as " circulari-ovata," longer than wide, and the lunella is said to be long, dorsal and deeply curved, that of *N. gracilis* being short and imperfect, only the upper part sufficiently developed to be visible.

Nenia sublutea Boettger Plate 18, figs. 3, 3a.

Nenia sublutea Boettger, 1909, Nachr.-Bl. d. m. Ges., p. 162.

The " circular-ovate " shape of the aperture, which is longer than wide, is characteristic. The type measures: " alt. 21½, diam. max. 4 mm.; alt. apert. 5, lat. apert. 4 mm."; 9 whorls. It came from the Rio Chanchamayo, 1000 m. (a rather indefinite locality around La Merced, about 60 km. northeast of Tarma). It has been known by a single specimen in the Boettger collection (now in Natur-Museum Senckenberg), and has not been figured.

A specimen from Rio Chanchamayo which I identify as *N. sublutea* is photographed in figs. 3 and 3a. It measures:

Length 19.8 mm., diameter 3.9 mm., aperture 4.3 mm. long, 3.5 wide; 8½ whorls.

The aperture being oblique is slightly foreshortened in the figure.

Nenia binkiae new species Plate 18, figs. 1, 1a, 1b.

The shell is entire, fusiform, widest at the penult whorl, rather thin, of 5½ to 6½ weakly convex whorls, the apex obtuse, the last whorl narrow, with nearly straight lateral outlines, the back evenly rounded. The surface is dull purplish-brown, matt, smoothish on about the first two whorls, later whorls with sculpture of rather strong, low, rounded and strongly slanting small riblets, decidedly more oblique than the faint growth-lines, somewhat narrower than their intervals; giving place, on the last half of the last whorl, to extremely fine and close striation.

The aperture is ovate, or it might be called somewhat pear-shaped. Peristome is nearly white, well expanded and lightly reflected, its face convex, somewhat thickened, at the sinulus a trifle retracted. The superior lamella is rather high, narrow, emerging to the lip edge; internally it rapidly becomes low and is continuous with the low spiral lamella, which does not penetrate as far as the inferior lamella. The inferior lamella is oblique, not very prominent, emerging to the inner margin of the lip, entering in a broad spiral curve to a latero-ventral position. The subcolumellar lamella is strong but short, terminating near, but shortly separated from, the lower end of the lunella. The principal plica is short, mainly lateral. The lunella is latero-dorsal, rather weakly curved, above recurving in form of a short upper palatal plica.

The clausilium (fig. 1b, external view) is but little curved lengthwise in the lower half, strongly curved transversely. The columellar margin is excised near the filament, and is more convex than the palatal margin. The rounded end is only slightly thickened.

Length 19.4 mm., diameter 5.1 mm.; 6½ whorls. Type.
Length 17.3 mm., diameter 5.3 mm.; 6 whorls.

Machu Picchu, on the Sacred Hill.[3] Type and figured paratype 185172 ANSP., collected by Elizabeth Pilsbry and the author.

The strongly oblique sculpture and the broad, blunt spire distinguish this species, which appears nearly related to *N. bartletti* (H. Ad.). It differs from that by the smaller size, stronger sculpture, and the inferior lamella being much broader within the back of the last whorl and ascending in a more ample spiral curve. The localities of these species are far apart.

Named for my companion at Machu Picchu and on many other Andean excursions; an efficient collector, who found the first specimen of this species.

Subgenus STEERIANA Jousseaume

Steeriana Jousseaume, 1900, Bull. Soc. Philomath. Paris, (9), 2: 34 (for *S. malleolata* and *S. steeriana*).

Steereana Pilsbry, 1926, Proc. Acad. Nat. Sci. Phila., 78: 10, 11 (teeth of radula).

Steeriana appears to be a derivative of the *Cylindronenia* stock, having similar sculpture, a deep basal sulcus and a rather prominent inferior lamella, but differing by the short, barrel-shaped shell, the strongly concave lateral outlines in the immature stage, and by the separation of superior and spiral lamellae. Type *N. steeriana* (Sykes).

They are ground snails, living under stones or other cover in high country of Cajamarca Department.

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[3] The places where this *Nenia* was found are within arm reach from the footway leading from the Chief Temple up the Sacred Hill. See the view given by Hiram Bingham, 1913, National Geographic Magazine, 24: 498. Also, Bingham, 1948, Lost City of the Incas, second plate following p. 170.

The number of species (one or two) is uncertain. The senior species of the group, *N. malleolata* (Phil.), is known only by Philippi's description and figures of the single specimen found. It is said to have no lunella, and if this is confirmed when it is collected again, the species will be considered distinct from *N. steeriana* which has a well-developed lunella. In other characters they are nearly alike.

Nenia malleolata (Philippi) Plate 19, figs. 4, 4a.

Clausilia malleolata Philippi, 1867, Malak. Blätter, 14: 194, pl. 2, figs. 3, 4.

The absence of a lunella, if confirmed, is an important feature of this species, but I imagine that the single specimen was not opened. In *N. steeriana* the lunella is plainly visible in an obliquely basal view in the aperture. The figures of *N. malleolata,* copied in my figs. 4, 4a, do not show the malleation which gave the species its name. Probably that sculpture, though visible to the naked eye, was too small to be brought out in the lithographic figures. Similar checkered or hammered appearance of the surface is to be seen also in some specimens of *N. steeriana* (see my figs. 1a, 2, 2c).

This species was found in the Andes between Contumaza and Cajamarca. Contumaza is a village southwest of Cajamarca and about 18 km. almost due south of Chilete.

Nenia steeriana (Sykes) Plate 19, figs. 2-2d, 3-3b.

Clausilia (*Nenia*) *steeriana* Sykes, 1893, Conchologist, 2: 101, 2 figs.

Steeriana steeriana Sykes, Jousseaume, 1900, Bull. Soc. Philomath. Paris (9), 2: 34.

Nenia steereana (Sykes), Boettger, 1909, Nachr.-Bl. d. m. ges., 41: 180; Pilsbry, 1926, Proc. Acad. Nat. Sci. Phila., 78: 10, 11, fig. 3 (teeth).

The truncate shell varies from barrel-shaped to cylindric, with matt, uneven surface and of a dirty buff color. The upper whorls are strongly crenate at the suture, but the suture becomes nearly even on the last one or two whorls. Sculpture of very fine superficial striation, and often marked with small, darker colored impressions which may be irregularly scattered or may form a rather close "malleation"; or usually nearly all striation may be worn away, leaving a smoothish surface. The early whorls usually show indistinct ribs below the sutural crenations. The last whorl has a basal furrow, the area between this furrow and the lip being coarsely striate and corrugated by a series of forwardly descending rounded ridges, but these ridges are often interrupted, irregular or subobsolete.

The somewhat squarish aperture has a well-expanding white peristome. The rather small, vertical, superior lamella is not noticeably concave on the left side, and is short. The spiral lamella is rather high at its upper end, in a dorsal position, but diminishes downward, and is separated widely or shortly from the superior lamella, and a little peripherad of that. The conspicuous, transverse, inferior lamella is strong within and ascends in a broad curve. It penetrates to the ventral side (or in the large form of the species to the dorsal side of the penult whorl). In many specimens there is a low callous ridge above the inferior lamella and subparallel to it, but it is usually rather indistinct. The lower end of the subcolumellar lamella is visible in oblique view in the aperture, a short distance from the end of the lunella. The principal plica is strong but rather short, dorsal. Lunella strong and deeply curved.

The clausilium of a paratype (fig. 2d), is narrow, tapering towards the narrow, bluntly pointed end, the columellar side convex, palatal side a little concave; the oblique end is thickened within.

Length 16.5 mm., diameter 7 mm.; 5-6 whorls. (Sykes, type in B.M.)
Length 18.2 mm., diameter 7.1 mm.; 5 whorls. Topotype.
Length 16.3 mm., diameter 7 mm.; 4¼ whorls. Topotype.
Length 15 mm., diameter 6.7 mm.; 4½ whorls. Topotype.
Length 15 mm., diameter 6 mm.; 4¾ whorls. Topotype.

" On the plains near Caxamarca, under stones " (J. B. Steere). A large variety occurs at 28 km. east of Cajamarca on the road to Celendín (H. A. and E. Pilsbry, 1948).

The above description, supplemental to that of Sykes, is from specimens of the original lot collected by Steere. The locality, " Plains near Caxamarca," I would take to mean the valley below Cajamarca city, but I saw no Neniae in the small time given to that rather unpromising area, though bulimulids are locally abundant.

In a series of three specimens (no. 480) in Museo Historia Natural Javier Prado, locality unknown, the color is dull cinnamon-drab to light gray. The clausilium (fig. 3b) is wider anteriorly than that of one of the original lot of *N. steeriana*. Two are figured in Pl. 19, figs. 3, 3a. These specimens measure:

Length 15.9 mm., diameter 6.4 mm.
Length 14.6 mm., diameter 6.1 mm.
Length 14.8 mm., diameter 6.6 mm.

About a thousand feet higher than Cajamarca on the road to Celendín, a form *major* of this species was rather abundant under stones in the grass. These specimens, figs. 1 to 1c, are nearly all larger than typical *N. steeriana*, but a few in the lot taken are no larger than some topotypes. Specimens measure:

Length 17.5 mm., diameter 6.9 mm.; 4½ whorls.
Length 18.7 mm., diameter 7.3 mm.; 4½ whorls.
Length 20 mm., diameter 7.8 mm.; 4½ whorls.
Length 21 mm., diameter 7.5 mm.; 5 whorls.
Length 21.3 mm., diameter 8.3 mm.; 4½ whorls.

The clausilium of this form (fig. 1e) is wider than that of typical *steeriana*, not tapering anteriorly except near the end, which is far more widely rounded than in typical *N. steeriana*.

The young shell has a smooth first whorl. The diameter increases slowly and regularly about to the end of the eighth whorl, then the shell widens rapidly. About 9 or 10 whorls are lost in the adult shell (fig. 1d).

Subgenus CYLINDRONENIA Ehrmann

Cylindronenia Ehrmann, 1949, Nautilus, 62: 104. Type *N. maranhonensis* (Albers).

This group and *Neniatracta* are related to *Steeriana* and probably to be ranked eventually as sections of that subgenus, though the shape is so different.

The larger species of *Cylindronenia* form a perplexing group, as there is great individual variation in most lots, and also local differentiation, though one species, *N. quadrata,* appears to be widely distributed.

The group divides into two series:

(1) Those with the clausilium quite oblique anteriorly, pointed at the palato-anterior end. This includes *N. maranhonensis* (Alb.), 1854, and *N. canescens* Pol., 1922. It is still questionable whether these two are specifically separable, but I think that they are. Both occur in the northern part of Cajamarca Department. *N. canescens* has been seen from several localities, including paratypes from Cutervo received from Dr. Polinski.

(2) Those in which the clausilium tapers very little to a rounded end. The senior species of this series is *N. quadrata* (Boettger), 1880. Unfortunately this species was never figured. It was described from a specimen in the collection of P. Joly,[4] the present location of which is not known to me, and the species has not been noticed by any subsequent author. However, I believe that *N. lubomirskii* Polinski, 1922, is not separable specifically from *N. quadrata.*

Boettger emphasizes the broad form and short last whorl of *quadrata,* and probably we have not yet found that typical form. The locality was given merely as " Peru ". *N. lubomirskii* was described from Cutervo, near Chota, far north in Cajamarca Department, but some specimens from Acobamba and Palca, in the Tarma district, are not distinguishable from Cutervo specimens I received from Dr. Polinski. It may be that *lubomirskii* can be retained as a subspecies of *N. quadrata,* having somewhat longer whorls, but this awaits rediscovery of typical *quadrata.*

The form found by Dr. Weyrauch at Carpapata, Rio Tarma, at 2200 to 2300 m., appears to be a valid subspecies, *N. quadrata boettgeri* Pils., 1945, distinguished mainly by its broad, flatly reflected peristome.

These several forms will be illustrated in a later paper.

Nenia sztolcmani Polinski

Nenia sztolcmani Polinski, 1922, Bull. Acad. Polon. Sci. Lettr., Ser. B, 1921, p. 138 (p. 18 of separata); Ann. Zool. Mus. Polon. Hist. Nat., 1: 70, pl. 8, figs. 20-22.

Nenia acobambensis Pilsbry, 1945, Nautilus, 58: 80, pl. 3, figs. 3, 4.

My identification of specimens from Acobamba as a new species was an error, as they agree well with Polinski's account of *N. sztolcmani,* the locality of which was unknown.

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[4] I am indebted to Dr. Adolf Zilch, Director of the Natur-Museum Senckenberg, for this information.

Nenia cumulloana new species Plate 20, figs. 3-3f.

The shell is decollate, somewhat fusiform, the width at the penult and the last whorl about equal; moderately strong; the whorls very slightly convex, the last whorl compressed, rounded basally, very shortly free and slightly descending in front. The surface is dull, with sculpture of low but rather large nodules below the suture, conspicuous by having white striae; the rest of the surface is dark brown, irregularly and quite shallowly pitted; the latter part, and especially the base, of the last whorl is corrugated by low, often indistinct ridges running to the basal lip; over the whole some very minute axial striation, chiefly visible on the subsutural tubercles and behind the outer lip, more or less obsolete elsewhere.

The aperture is between ovate and trapezoidal, dark brown within. The peristome is rather narrowly reflected, white. The superior lamella emerges to the edge of the peristome and is strongly concave on the left side; internally it is continuous with the spiral lamella. The inferior lamella is rather low and receding, weakly notched or at least straightened at its crest, in a front view; within it is high, weakly spiral, ascending to a lateral position. The lower end of the subcolumellar lamella runs barely past the end of the lunella (fig. 3f). The principal plica is about a half whorl long, running from a lateral position to within about 1.3 mm. of the peristome. The lunella is quite strong, arcuate and white, showing through whitish on the outside. The end of the subcolumellar lamella can be seen in an obliquely basal view in the aperture. The lower end of the lunella is shortly curved inward, somewhat simulating a lower-palatal plica (as in fig. 3f); but this is sometimes less developed than in the figure, the end being merely angularly truncate.

The clausilium (figs. 3d, 3e) is strongly curved both lengthwise and transversely. The greatest width is about the middle of the spatula. The columellar margin is evenly arcuate, distinctly more convex than the palatal margin, which also has nearly even but weaker curvature. The end is narrowly rounded and strongly thickened.

Length 14.3 mm., diameter 4.0 mm.; 4½ whorls. Type.
Length 15.7 mm., diameter 4.5 mm. 4½ whorls.
Length 13.2 mm., diameter 3.7 mm. 4½ whorls.
Length 13.6 mm., diameter 4.0 mm. 4⅓ whorls.
Length 17.3 mm., diameter 4.1 mm. 5½ whorls.

Road from Cajamarca to Celendín at kilometer 73, in the Cordillera de Cumulloa; living on the ground, under stones (limestone); elevation not measured but probably not far from 4000 m. Type and paratypes 185165 ANSP. Also in grassland near the top, at km. 82. Collected by the author and Elizabeth Pilsbry, June, 1948.

This species is very nearly related to *N. wagneri* Polinski, from Amable Maria (a place about 550 km. southeast of our locality), but it differs from that in numerous details. The surface does not show the " breite aber sehr wenig erhabene, faltenartige Rippen, die von links oben nach rechts unten verlaufen " of *N. wagneri*, but only a very irregular and shallow pitting, ant there are strong subsutural nodules in *N. cumulloana* which *wagneri* does not show. In *N. cumulloana* the superior lamella emerges conspicuously to the lip edge, but it is described and figured for *N. wagneri* as not reaching the margin of the aperture. *N. wagneri* has 6½ whorls remaining in the decollate shell, while *N. cumulloana* has only 4½, or in one specimen 5½, but the upper whorl is empty, being above the plug.

In external characters *N. cumulloana* has some resemblance to the larger *N. polinskiana,* both having the suture bordered by rather conspicuous nodules, and the last whorl is obliquely corrugated; but in *N. cumulloana* the corrugation is weaker and less regular. The subsutural nodules are sometimes partially obsolete on the last whorl or two.

A young shell 11.6 mm. long with the apex perfect has 8½ whorls, which increase regularly except for a slight attenuation near the apex.

Nenia wagneri Polinski Plate 20, figs. 2-2b.

Nenia wagneri Polinski, 1922, Bull. Acad. Polonaise Sci. et Lettr. for 1921, Classe Sci. Math. et Nat., p. 127; Ann. Zool. Mus. Polonici Hist. Nat., 1: 61, pl. 7, figs. 1-3.

The original figures of this species are reproduced for comparison with *N. cumulloana.* The size was given as: length 15.5 to 17.2 mm., width 4 mm., 6½ whorls. The locality is Amable Maria, three specimens in the Polish Museum at Warsaw, collected by K. Jelski.

On account of its sculpture, Polinski placed *N. wagneri,* together with *N. perarata* (Mouss.) and *N. pusilla* Pol., in the subgenus *Nenia* s. str.; but none of these are nearly related to the Porto Rican type of *Nenia.*

Subgenus NENIATRACTA Pilsbry

Neniatracta Pilsbry, 1926, Proc. Acad. Nat. Sci. Phila., 78: 10. Type *N. belahubbardi* Pils.

This series comprises slender, entire *Neniae* related to *Cylindronenia* by the fine striation, the occasional development of a basal sulcus and a chalky outer coat, though these are often lacking.

Nenia adusta (Boettger)

Clausilia (Nenia) adusta O. Boettger, 1880, Nachrbl. d. m. Ges., 12: 111.

Nenia adusta Bttg., Polinski, 1922, Ann. Zool. Mus. Polonici Hist. Nat., 1: 69, pl. 8, figs. 16-19.

Clausilia (Nenia) pampasensis Pilsbry, 1910, Proc. U. S. National Mus., 38: 181, fig. 4; 1945, Nautilus, 58: 80.

N. adusta belongs to the group of *N. angrandi,* in which the inferior lamella is conspicuously receding, the spiral lamella much shorter than the inferior, penetrating only to the dorsal line, and the striation is fine and irregular. *N. adusta* is a larger species with more whorls than *N. angrandi.*

Dr. Boettger did not illustrate this species, which was described from a single specimen in the Joly collection; the locality in Peru and the collector are unknown. Polinski identified specimens in the Warsaw Museum as *adusta,* and he called attention to the resemblance of *N. pampasensis* to that species. On renewed examination of the type of "*Clausilia*" (*Nenia*) *pampasensis*, I am inclined to consider it a synonym of *N. adusta*, although there are certain small differences. The color of *pampasensis* is darker than *adusta*, and it is not bicristate at the base; however, on close examination the weak trace of a single angulation of the otherwise rounded base can be seen. The basal sulcus seems always to be a variable feature. The locality of *N. pampasensis* is along a highway dating back to Inca times, which quite possibly was used by the unknown scientific traveller of about three-quarters of a century ago who picked up the original specimen of *N. adusta*.

For comparison with *N. adusta*, the description of "*Clausilia*" *pampasensis* and figures of the type are given here. There were misleading typographic errors in the description as printed originally, corrected here.

Clausilia (*Nenia*) *pampasensis*. (Pl. 21, figs. 1, 1a; pl. 22, fig. 3.) The shell is [entire,] slender, fusiform, somewhat attenuated near the apex, lusterless, gray-white over a dull brown surface [which is] visible where the outer sculptured layer is rubbed off. Sculpture of very fine and close, unequal and uneven striae in the direction of growth lines. In places they are discontinuous, forming long, lanceolate granules. This white striate layer is worn off on the ventral side of each whorl. Whorls 12¼, the first two brown and glossy. To the fourth or fifth whorl the diameter scarcely increases; then the whorls increase slowly in diameter to the penultimate which is widest, and, like those preceding, is moderately convex. The last whorl is flattened [laterally,] tapers toward the base, and finally becomes free, descending more rapidly to the aperture, which stands forward about 1 mm. The neck is deeply grooved above [by] the suture.

The aperture is [faintly brownish within,] slightly oblique, rounded-ovate, with continuous, reflected, pale brownish peristome. The superior lamella is acute, concave on the left side, continuous with the spiral lamella, which is low and short, running inward to a dorsal position. The inferior lamella is [receding,] barely visible in a front view. It ascends in a long sigmoid curve, and is somewhat thickened within. The subcolumellar lamella is wholly immersed. The principal plica is high, dorsal, and less than a half whorl long. The lunella is low and lunate.

The clausilium (pl. 22, fig. 3) is strongly curved transversely. The palatal side is more convex than the columellar, which is excised next to the filament. The lower half of the spatula tapers to the narrow but blunt end, and is thickened within along the middle and end.

Length 20.2, diameter 3.9 mm.; longest axis of aperture 3.8 mm., (vertical length 3.6 mm.), width 3 mm.

Right (east) bank of the Rio Pampas, near the bridge, on the road from Chinceros and Bombon to Pajonal, at about 6000 ft. elevation (Dr. Hiram Bingham).[5] Type 209272 USNM. It is known by a single specimen which I figure. The original figure was incorrect, especially in drawing of the last suture.

N. belahubbardi Pils. has a larger shell, with more strongly developed, unworn sculpture and a longer aperture.

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[5] A picture of the locality was given in Proc. U. S. Nat. Mus., 38: 178, fig. 1.

Nenia adusta weyrauchi Pilsbry Plate 21, figs. 2-2c.

Nenia weyrauchi Pilsbry, 1945, Nautilus, 58: 82, pl. 3, fig. 5.

This form from Ninebamba, on the Rio Pampas, only a few km. from the wire bridge near which *N. pampasensis* was collected, appears from a comparison of the types to differ from *pampasensis* only by being smaller and slightly more slender. None of the specimens seen contained the clausilium, which should be compared with that of *pampasensis*.

For the present it is considered a subspecies of *N. adusta,* but further collecting may perhaps show that it is only a local small form, not a valid subspecies. Specimens figured measure:

Length 18.9 mm., diameter 3.2 mm.; length aperture 3.2 mm.; 12⅓ whorls.
Length 16.3 mm., diameter 3.0 mm.; length aperture 3.0 mm.; 11¾ whorls.
Length 16.0 mm., diameter 3.3 mm.; length aperture 3.0 mm.; 11⅓ whorls.
Length 14.3 mm.; 11¼ whorls.

Nenia angrandi (Morelet) Plate 21, fig. 6.

Clausilia angrandi Morelet, 1863, Séries Conchyliologiques, 3 livr., p. 212, pl. 11, fig. 12.

" Le test, d'un brun corné tirant sur le roussâtre, est couvert de fines stries blanchâtres, plus ou moins flexueuses, plus ou moins interrompues, distribuées irrégulièrement et ayant une apparence vermiculaire; excessivement fines sur les premiers tours de la spire, elles deviennent très sensibles sur les derniers, et acquièrent même une certaine épaisseur aù point ou elles traversent la carène dorsale."

Le dernier tour " porte une carène dorsale assez fortement crénelée par les stries qui vont y aboutir."

Length 14 mm., diam. 3.5 mm.; 10 whorls.

Maraynioc, in the *montaña* de Tarma, that is, in the gorges of the valley of Vilcabamba along the Vilcamaya (M. L. Angrand, in Peru, 1834-1843).

The diagnostic points of Morelet's description (other than those shown by his figure, which I reproduce photographically) are quoted above. He emphasizes the prominence of the striae where they pass over the basal keel. This character has not been observed in any specimens of the two races noticed below.

Some account of this species is given above for comparison with the forms here associated with it as subspecies. It is apparently a widely distributed species. I have recognized the northern (*huanucensis*) and the southern (*urubambensis*) forms as subspecies, but further collections may possibly show that the geographic range is continuous, and that the small structural difference of *urubambensis* intergrades too fully to make subspecific separation worth while. *N. a. huanucensis* appears to be distinct by the convex lateral outlines of the spire, which is not attenuated above as in *angrandi*.

Nenia angrandi urubambensis Pilsbry Plate 21, figs. 3, 3a, 3b.

Nenia angrandi urubambensis Pilsbry, 1945, Nautilus, 58: 83, pl. 3, fig. 8.

The clausilium is drawn in pl. 22, fig. 2. The spatula is widest at the upper third, and is strongly excised on the columellar side of the filament. It tapers to a narrowly rounded end which is rather strongly thickened.

Specimens from the type locality, Huadqucña, Vilcanota Valley, 1500 m. (head of the Urubamba valley), are figured. Four measure:

Length 11.2 mm., diameter 2.8 mm.; 8½ whorls.
Length 13.2 mm., diameter 3.2 mm.; 9 whorls.
Length 14.2 mm., diameter 3.3 mm.; 10⅓ whorls.
Length 14.3 mm., diameter 3.0 mm.; 10¾ whorls.

Nenia balnearum Crawford (Proc. Malac. Soc. London, 23: 321, pl. 19, fig. 13) from near Cusco, appears to differ from *N. a. urubambensis* by having flatter whorls and a more prominent inferior lamella, according to the figure. I have not seen that species.

Nenia angrandi huanucensis new subspecies Plate 21, figs. 4-4c, 5.

The shell is entire, fusiform with blunt apex which is smooth and brown. The whorls are rather strongly convex in the upper half, the penult whorl widest, less convex, the last whorl becoming free and descending, somewhat built forward to the aperture, having a median furrow at the base, between two rounded ridges, this structure sometimes well developed, but usually the furrow and ridges are weak or sometimes almost obsolete. The suture is moderately impressed. The surface is matt, dull flesh-tinted, closely sculptured with fine whitish striae which are somewhat irregular and unequal, about 20 in one mm. on the penult whorl; on the last half of the last whorl the striae become coarser and more widely spaced. In some specimens the striae become obsolete in spots arranged below the suture, making it appear crenated.

The aperture is rounded with truncate upper margin, the interior nearly white. Peristome is rather broadly reflected, thick and white. The superior lamella is marginal, strong, concave on the left side, and wholly continuous with the spiral lamella which is very low and short. The inferior lamella is receding, strong, rather weakly sigmoid in the last whorl. The subcolumellar lamella connects with the lower end of the weak, nearly straight lunella, which is rather indistinct from its brown color. The principal plica is strong but short, less than one-fourth of a whorl long, extending from a dorsal to a lateral position.

The clausilium (pl. 22, fig. 1) is rather wide, strongly curved in the upper half, the columellar margin very much more strongly arcuate than the palatal margin and thickened within, and it is somewhat excised near the filament. The end is somewhat thickened within.

Length 11.5 mm., diameter 2.8 mm.; 8½ whorls. Huánuco. Type.
Length 11.7 mm. diameter 2.7 mm.; 8½ whorls. Huánuco.
Length 11.1 mm. diameter 2.8 mm.; 8 whorls. Huánuco.
Length 10.5 mm. diameter 2.8 mm.; 8 whorls. Huánuco.
Length 10.9 mm. diameter 2.7 mm.; 8 whorls. Ambo.

Huánuco, 1900 m. Type and paratypes 183975 ANSP., from W. Weyrauch's No. 45. Also taken at Ambo (Weyrauch).

This little snail apparently stands very near *N. angrandi* (Morelet), but it is smaller, *the spire less attenuated,* with only 8 or 9 whorls instead of 10, and the striae are not noticeably thickened where they pass over the basal keel. The shape of the base is variable; occasional specimens have the sulcus and keel strongly developed, as in fig. 4b, while in others there is only a slight irregularity of the rounded base. More frequently the angulation is moderately distinct. The columellar margin of the clausilium is more convex than in *N. a. urubambensis.*

I found slightly longer specimens at a crag high on a barren hill at the edge of the town of Huánuco, the largest measuring: length 12.7 mm., diameter 2.7 mm.; 9 whorls.

Specimens from Ambo (pl. 21, fig. 5) average smaller than any from Huánuco.

HEMICENA new subgenus

The shell is Nenia-like externally, and has well-developed superior and inferior lamellae, but there is no clausilium, no palatal folds or lunella. Type *N. polinskiana,* new species.

Besides the type, *Nenia warszewiczi* Polinski and possibly the Venezuelan "*Balea*" *funcki* Pfeiffer, may belong to this group. I have seen neither of them.

The Carpathian *Alopiae* which are deficient in closing apparatus are mountain forms,[6] and the degeneration of these structures may be owing to the absence at high elevations of some Clausilia predators. I do not know that this has been investigated. *Balea, Austrobalea* and *Reinia,* which also have lost clausilium and folds, are not high mountain snails. In Peru, *Temesa* lives only at high elevations, and has lost all protective armature. However, the *Neniae* of the Andes, excepting only the few species of *Hemicena,* do not show any tendency towards degeneration of the closing apparatus.

Nenia polinskiana new species Plate 20, figs. 1, 1a, 1b.

The shell is entire, rather thick and strong, slender and somewhat fusiform, widest at the penult whorl, thence tapering regularly to the small but obtuse apex. The whorls are very slightly convex, nearly flat, the last whorl only very shortly free and not descending in front. Color brown, with more or less of a chalky white over coat, or sometimes whitish throughout, the surface dull, the least worn individuals showing an extremely fine, close, slightly irregular striation in places; a close, regular series of nodules borders the suture; the last whorl is broadly rounded at base, its last half conspicuously corrugated by rounded protractive ridges (usually about ten) running to the lip.

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[6] See in this connection, C. R. Boettger, 1925, Archiv für Naturgeschichte, 91 Jahrg., Abth. A. 5 Heft, pp. 3, 4.

The aperture is piriform, chestnut-brown within. Peristome is white, reflected and somewhat thickened. The superior lamella is rather short, marginal, concave on the left side, contiguous to, or shortly separated from, the spiral lamella, or continuous with it, though very low at the junction. The spiral lamella is low and short, penetrating to a mid-dorsal position. The inferior lamella is low, white, remote from the superior lamella, and extending to the inner margin of the lip; inside it is a little thickened and ascends vertically, being either wholly concrescent with the columellar axis or distinct and very close to it as in fig. 1b. There is no subcolumellar lamella, no folds or lunella on the palatal wall, and no clausilium.

Length 19.9 mm., diameter 4.6 mm. 10 whorls. Paratype.
Length 21.4 mm., diameter 5.0 mm. 10.3 whorls. Type.
Length 22.7 mm., diameter 5.2 mm. 10.3 whorls. Paratype.
Length 24.6 mm., diameter 5.1 mm.; 11 whorls.

Tapacocha, Rio Fortaleza, at 3000-3500m., on the western slope of the Andes (inland from Pativilca in the northwestern part of Dept. Lima). Type and paratypes 185113 ANSP.; also 185114 ANSP. Collected by Dr. W. Weyrauch (no. 481 of his collection).

This species is readily recognizable by the strong, though variable, corrugation of the back of the last whorl, and the coarsely crenate suture. Nearly all adult specimens seen are more or less worn, losing most or all of the hair-fine striation. Internally it is remarkable for the absence of palatal folds, lunella and clausilium, and the straightly vertical ascent of the inferior lamella within the last whorl.

By its interior characters it recalls *N. warszewiczi* Polinski, but differs in detail, *N. polinskiana* having a short spiral lamella and no subcolumellar lamella, while *N. warszewiczi* is said to have no spiral lamella, but a subcolumellar is present; both species lacking palatal folds and clausilium. The two species differ notably in size and shape also, *N. warszewiczi* being entire, smoothish, 14.2 × 3.5 mm. with 8½ whorls. Its locality in Peru is unknown.

Numerous fresh specimens of *N. polinskiana* were taken but none living, so the radula could not be examined.

The species is named for the late Dr. Wladyslaw Polinski, author of admirably lucid and thorough papers on Peruvian Clausiliidae.

Subgenus GRACILINENIA Polinski

According to Thiele (Handbuch Syst. Weichtierkunde, 1: 535) the type of this group, *N. filocostulata* (Lubomirski), has a radula like that of *Peruinia*. The following species will therefore be transferred to that genus if it proves to have that type of teeth.

Nenia huallagana new species Plate 22, figs. 4-4f.

The shell is thin, translucent, slenderly fusiform, truncate, six or seven whorls remaining; the whorls are strongly convex, the last narrower, tapering downward, its last half free, produced forward to the oblique aperture. The surface is glossy, " corneous " (translucent, pale buff-gray), with sculpture of thin whitish riblets or laminae, noticeably unequal, separated by much wider intervals, and weaker, or often deciduous, on the earlier whorls.

The aperture is about as wide as long, somewhat squarish, the upper margin straightened, outer margin weakly convex, the basal and columellar margins strongly convex; peristome white, reflected. The superior lamella is narrow, but rather high, emerging to the lip edge; it diminishes within, and connects with the short but sharp spiral lamella by a low curved callus (as in fig. 4a). The inferior lamella is deeply placed, not visible in front view of the aperture, but in an obliquely basal view it appears straight and *parallel to the superior lamella* (fig. 4b); viewed from the back (fig. 4a) it is strong, high and very little curved; inwardly it ascends nearly to the mid-ventral line. The subcolumellar lamella is very deeply immersed, its upper part very broad, its lower end extending past the lower end of the lunella. The principal plica is short and dorsal. There is a weak and low, strongly curved lunella.

The clausilium (fig. 4) is short and broad, well curved both longitudinally and transversely, tapering a little towards the end and decidedly thickened there. It is somewhat excised on the columellar side of the filament.

Length 11 mm., diameter 2.7 mm.; 6 whorls remaining. Fig. 4d.

Tingo Maria, in a dense and rocky thicket at the west end of the Rio Huallaga bridge to the airport. Type and paratypes 185174 ANSP., collected by Elizabeth Pilsbry and the author. Also, Cueva de los Lechuzas, Rio Rondos (W. Weyrauch, no. 532).

The small size, long neck, glossy surface and spaced rib-striation of this fragile, fusiform shell are the more noticeable external features, but the very deep immersion of the inferior lamella and the peculiar shape of its lower end as seen in an obliquely basal view in the aperture, as well as the weakness of the lunella, are other prominent characters.

It was found in some abundance at the type locality, but unfortunately nearly all of the lot was lost in a fall. I did not get back to that place again.

EXPLANATION OF PLATES

PLATE 17

Figs. 1, 1a.—*Nenia callistoglypta* form *dextroversa.*

Figs. 2-2b.—*Nenia callistoglypta,* type (2b) and paratypes photographed to same scale.

Fig. 2c.—*Nenia callistoglypta,* outside view of clausilium .

Fig. 3.—*Nenia olssoni,* clausilium, inside view.

Figs. 3a, 3b, 3e.—*Nenia olssoni,* type ; fig. 3b × 10.

Figs. 3c, 3d.—*Nenia olssoni,* paratype.

Size lines indicate the actual length.

PLATE 18

Figs. 1, 1a.—*Nenia binkiae*, type and paratype, actual size and enlarged; 1b, clausilium.

Figs. 2-2b.—*Nenia atracta*, type; 2c, clausilium.

Figs. 3, 3a.—*Nenia sublutea* Bttg., specimen from Chanchamayo.

Figs. 4, 4a.—*Nenia gracilis*, type; 4b, clausilium.

PLATE 19

Figs. 1-1d.—*Nenia steeriana*, large form from 28 km. east of Cajamarca, enlarged and actual size; 1e, clausilium.

Figs. 2-2c.—*Nenia steeriana*, shells of original lot collected by J. B. Steere; 2d, clausilium.

Figs. 3, 3a.—*Nenia steeriana*, locality unknown; 3b, clausilium.

Figs. 4, 4a.—*Nenia malleolata*, photographic reproduction of original figures.

Second line of figures and figs. 4, 4a, actual size, the others enlarged.

PLATE 20

Figs. 1-1b.—*Nenia polinskiana*, type and two paratypes, enlarged and actual size.

Figs. 2-2b.—*Nenia wagneri* Polinski, × 5. After Polinski.

Figs. 3-3c.—*Nenia cumulloana*, type and paratypes, enlarged and actual size.

Figs. 3d, 3e.—*Nenia cumulloana*, external and internal views of clausilium.

Fig. 3f.—*N. cumulloana*, the last whorl opened from the left side, showing (from left to right) the lunella, end of the subcolumellar lamella, the inferior lamella and the superior lamella.

PLATE 21

Figs. 1, 1a.—*Nenia adusta* Bttg. (type of *Clausilia pampasensis*), enlarged and actual size.

Figs. 2-2d.—*Nenia adusta weyrauchi*, topotypes, enlarged and actual size.

Figs. 3-3b.—*Nenia angrandi urubambensis*, topotypes, enlarged and actual size.

Figs. 4-4b.—*Nenia angrandi huanucensis*, type and paratypes, enlarged; size lines indicate actual length.

Fig. 4c.—*Nenia angrandi huanucensis*, opened to show lamellae.

Fig. 5.—*Nenia angrandi huanucensis*, specimen from Ambo.

Fig. 6.—*Nenia angrandi* (Morelet), photographic copy of the original figure.

PLATE 22

Fig. 1.—*Nenia angrandi huanucensis*, clausilium.

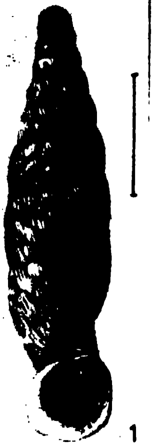
Fig. 2.—*Nenia angrandi urubambensis*, clausilium.

Fig. 3.—*Nenia adusta* (type of *C. pampasensis*), clausilium.

Fig. 4.—*Nenia huallagana*, clausilium.

Figs. 4a, 4b.—*Nenia huallagana*, interior of last whorl opened, dorsal view, and obliquely basal view in aperture, showing anterior ends of superior and inferior lamellae.

Figs. 4c, 4f.—*Nenia huallagana*, type (fig. 4d) and three paratypes, enlarged.



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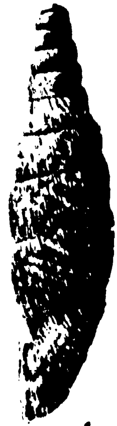

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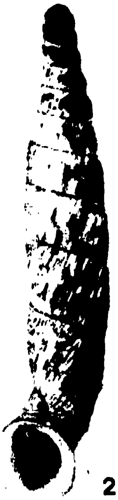

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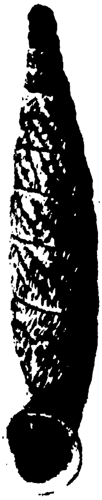

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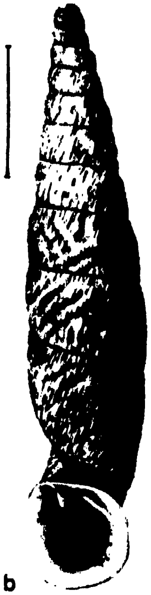

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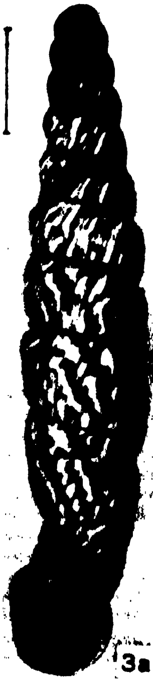

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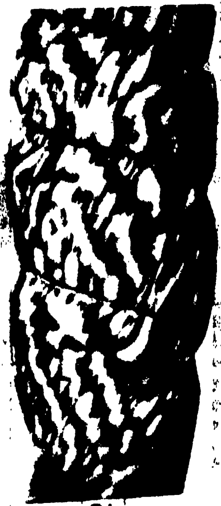

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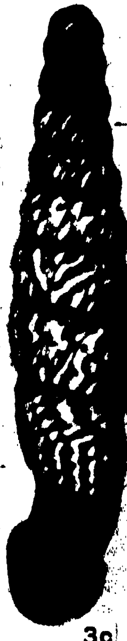

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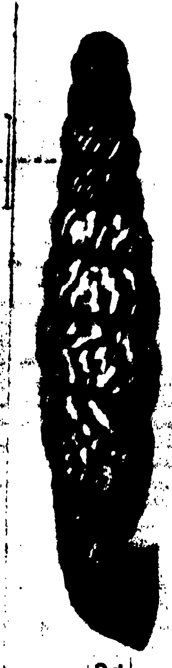

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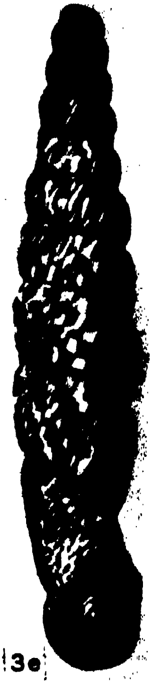

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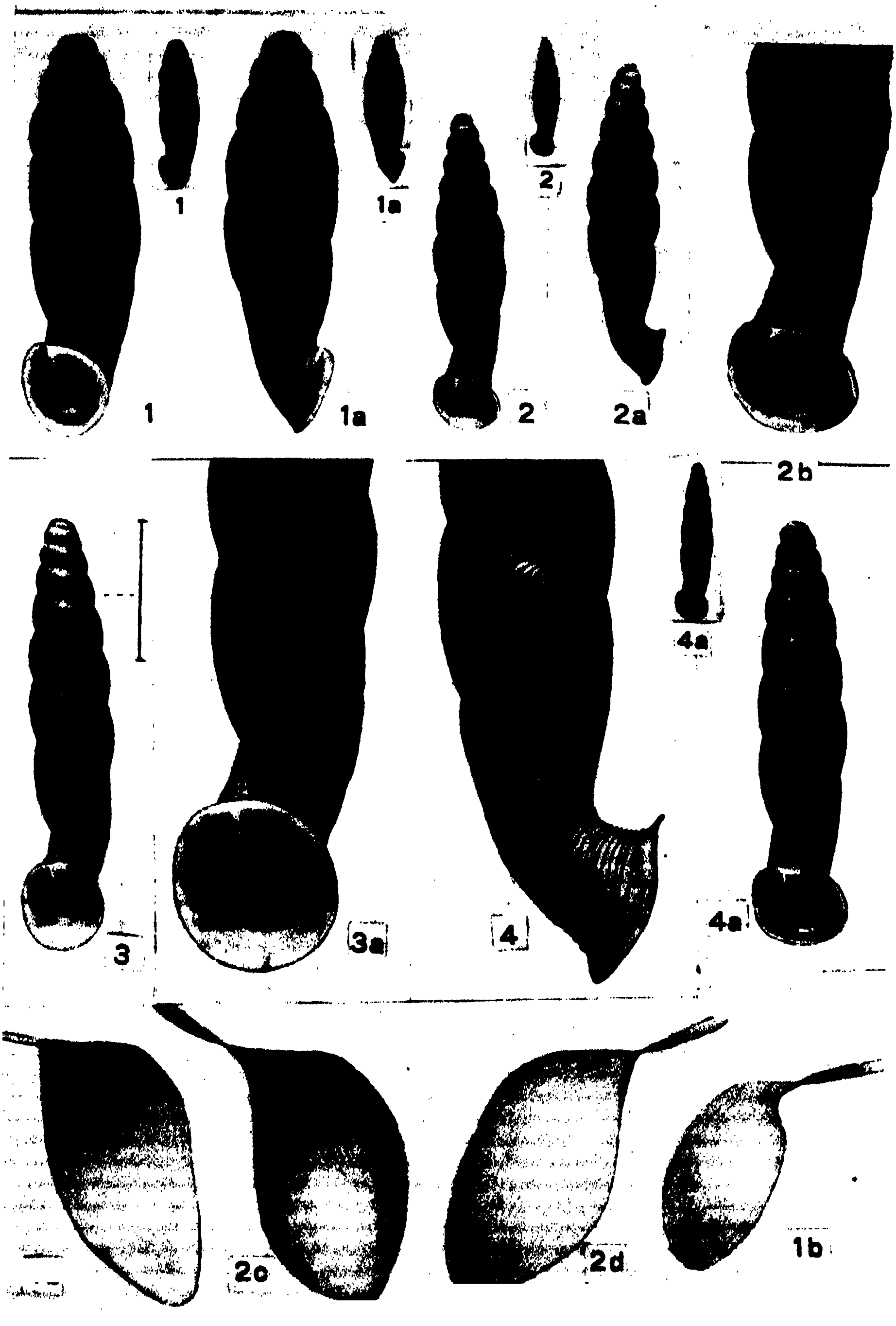
PILSBRY: PERUVIAN LAND MOLLUSKS



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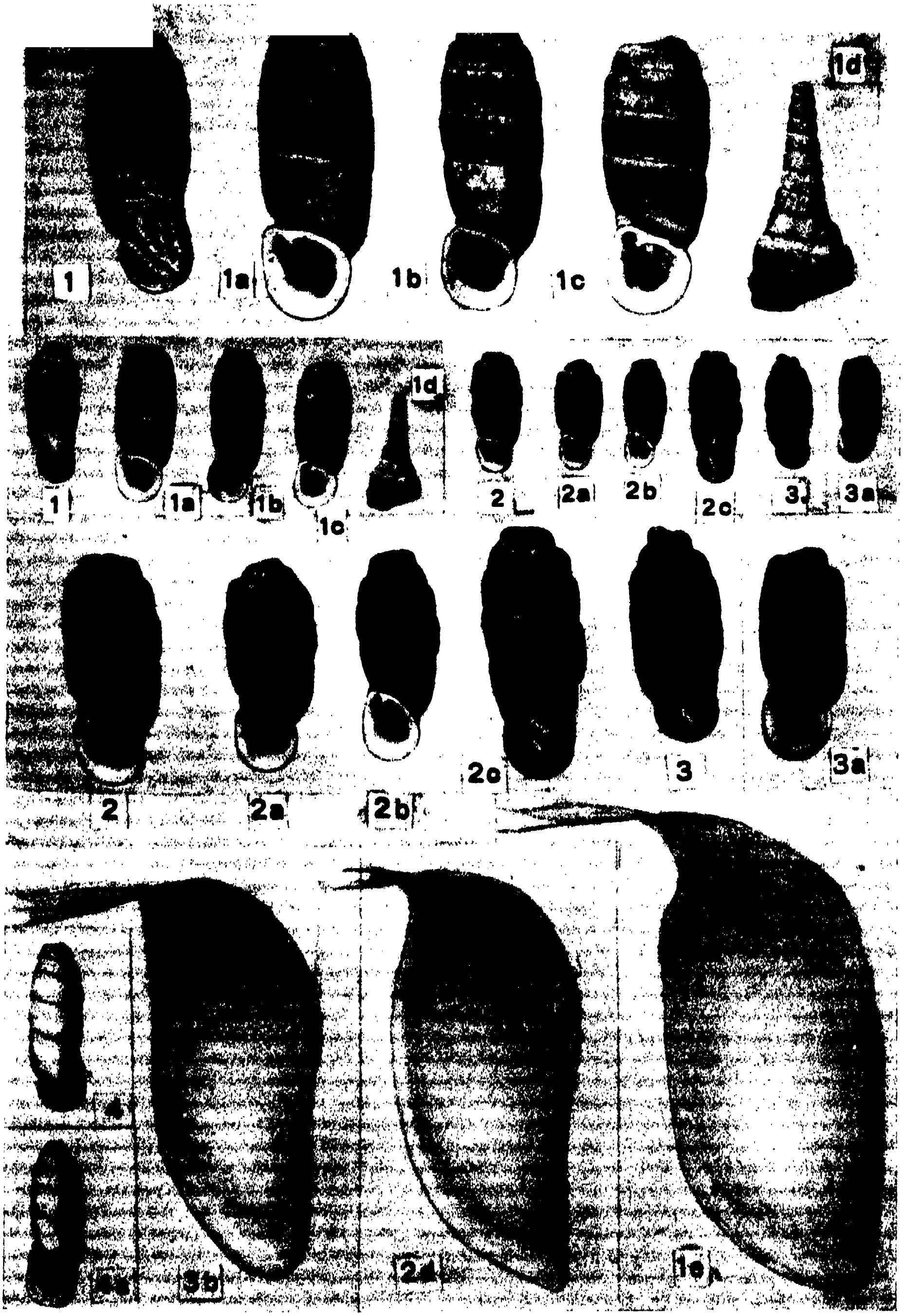

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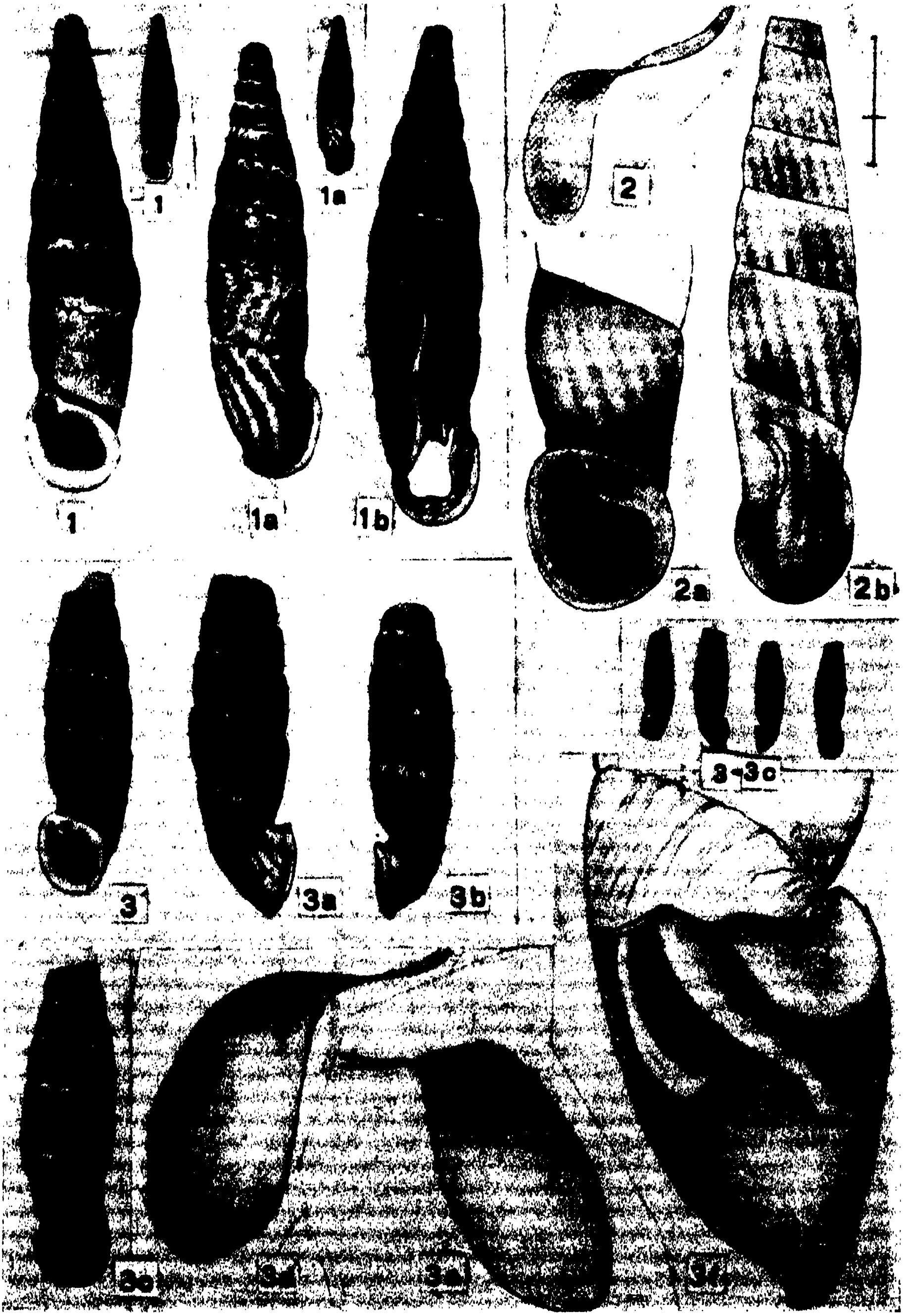

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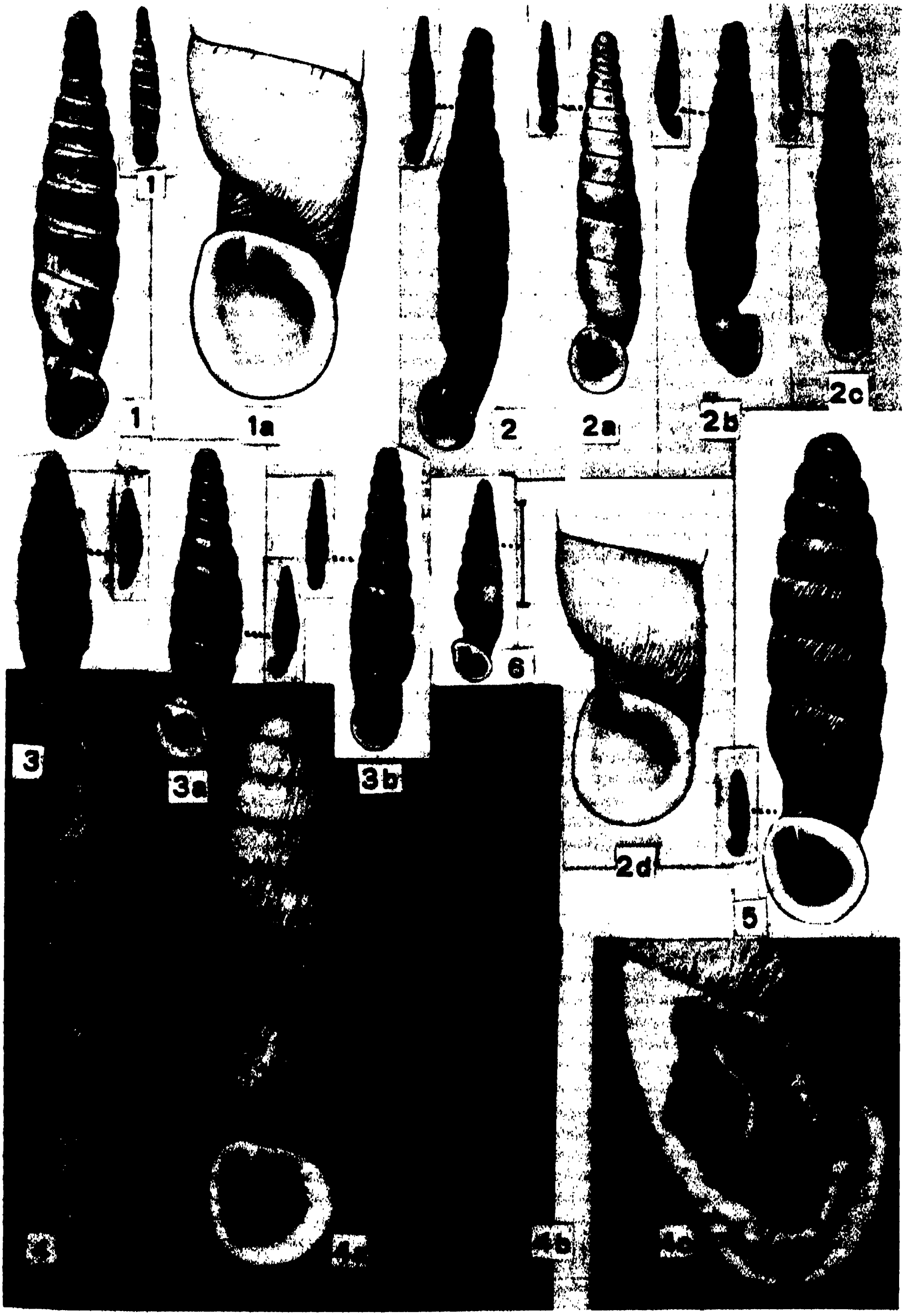

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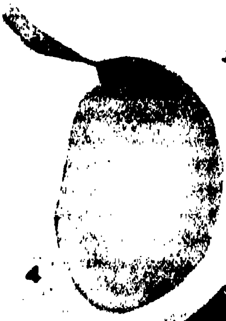

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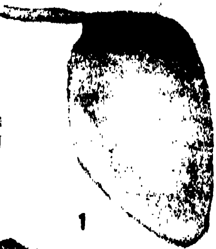

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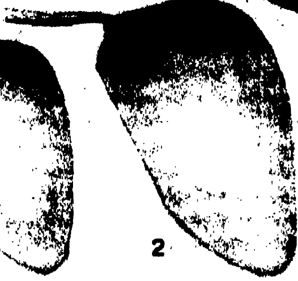

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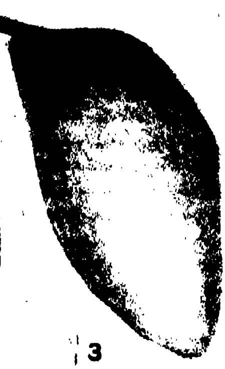

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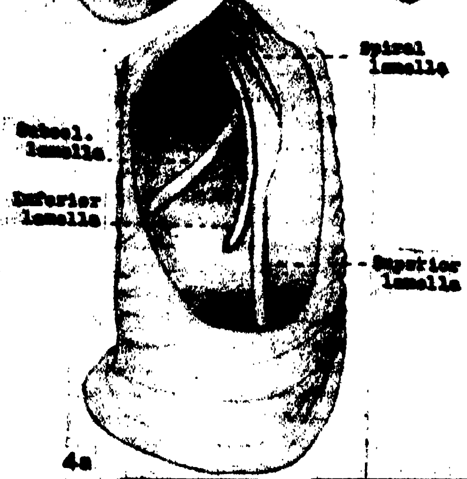

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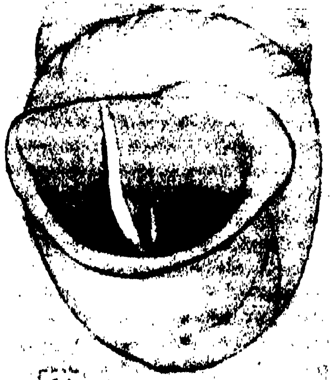

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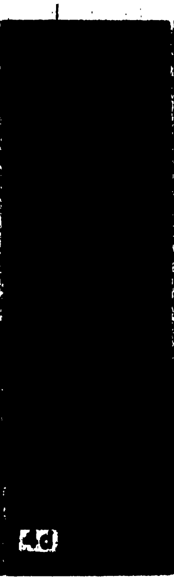

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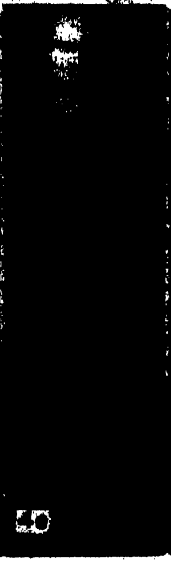

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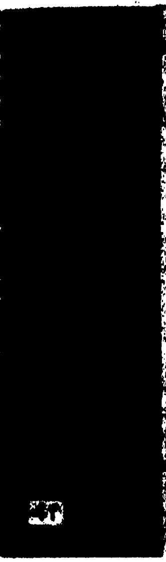

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PILSBRY: PERUVIAN LAND MOLLUSKS

RESULTS OF THE TWO CARPENTER AFRICAN EXPEDITIONS, 1946-1948
PART II—THE FISHES

BY HENRY W. FOWLER

Curator of Fishes, The Academy of Natural Sciences of Philadelphia

The present paper is based upon fishes collected by the two Carpenter African Expenditions of 1946 and 1948.[1]

In June of 1946, Mr. William K. Carpenter of Wilmington, Delaware, a Trustee of this Academy, and his wife, Francis, left Philadelphia on an expedition to Africa for the purpose of collecting specimens toward the completion of the exhibits in our African Hall, and also for the collection of zoological research materials for the use of the scientific staff of this Academy. This expedition, and that of 1948, were financed by Mr. William K. Carpenter and his father, the late R. R. M. Carpenter, for many years a generous benefactor of this institution.

At Nairobi, British East Africa, the party was joined by Dennis and Donald Ker, who assisted in the outfitting and progress of the expedition. On September 10, the departure was accomplished and the route led through Tanganyika to Lundazi in Northern Rhodesia where large mammals were collected for the Museum. From there the party continued to the Luangwa River and thence to the Kufue River near Lusaka. Collections of fish were taken in both streams. At Lundazi, Mr. Errol Button, District Commissioner and a naturalist, rendered a great deal of assistance in facilitating the collecting of fish and mammals. After visiting Victoria Falls, the party returned to Nairobi on October 30, 1946.

A large collection of fish was made during the expedition, but at some point in transit to the Academy the alcohol was drained off, so that a large portion of the collection was destroyed. This paper is based on the material that was salvaged, and that taken in 1948.

Between November 1947 and May 1948, Mr. Carpenter led a second African Expedition for the purpose of photographing native and animal life and for securing specimens. Special objectives were: the photographing of the gorilla, and obtaining of material for a Sahara Desert habitat group. The expedition traveled some 11,000 miles across central Africa and into northern Africa.

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[1] The birds collected on this expedition are reported upon by Mr. de Schauensee in Notulae Naturae, Acad. Nat. Sci., Phila., no. 219, 1949.

Associated with Mr. Carpenter was Harold T. Green, Curator of Exhibits of the Academy. François Edmond-Blanc, of Paris, France, joined the expedition at Brazzaville and facilitated progress through French territory, as well as assisting in the collection of specimens. The main route of the trip extended from Nairobi across the Belgian Congo to Brazzaville in French Equatorial Africa. Here a side excursion was made some 200 miles north to the first fish and bird collecting station at Oka. Also, motion pictures of gorillas were secured near this place. Upon returning to Brazzaville, the expedition moved through the Gaboon and the Cameroons to Banqui, on the Ubangui River. It then proceeded about 300 miles north-northeast to N'délé, and on by way of Fort Crampel to Fort Archambault, in the Territory of Chad.

From this point the party passed northeastward through Abéché and Oum Chaluba to Fort Fada, in the Ennedi Mountains. In this area Barbary Sheep (*Ammotragus lervia blanei* Rothschild) were collected for a new museum group. The officers of the Camel Corps, stationed at Fort Fada were most helpful in assisting the expedition to obtain its objectives.

The trip then continued to Fort Lamy without stopping to collect specimens, and the return to the United States was accomplished by air from this point.

Sincere gratitude is here expressed to Mr. Carpenter by the Academy for the material obtained on these two expeditions. These specimens are particularly valuable because they were secured in remote regions seldom visited by naturalists and most of them were not previously contained in our collections. The Academy and members of the expeditions also express their appreciation to the French Government and the Governors General of French Equatorial Africa and Chad for their valuable help and many personal courtesies extended to the expedition.

FRESH-WATER FISHES OBTAINED IN THE ZAMBESI SYSTEM IN 1946

All fishes from this first expedition bear the label Kafue River, Malabuka, Rhodesia, October 1946. Though these specimens number 705 individuals I determine them as eight species, one appearing to be new. Fishes from the Zambesi are particular desiderata in American museums, so the Academy is fortunate to have received them as among the first contribution to our collections from the Zambesi basin.

MORMYRIDAE

Marcusenius castelnaui Boulenger

One, 72 mm. D. 16. A. 24. Depth $3\frac{2}{5}$. Head $3\frac{3}{5}$.

Barnard[2] has allocated Gilchrist and Thompson's misidentification of *M. isidori* from Kafue River specimens to *M. castelnaui* Boulenger.

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[2] Ann. S. Afr. Mus., vol. 36, pt. 5, June 1948, p. 412.

CITHARINIDAE

Nannocharax multifasciatus Boulenger

Seven, 23 to 28 mm. According to Barnard, *N. minutus* Worthington 1933 is a questionable, and *Distichodus stigmaturus* Fowler 1935 is an acceptable synonym.

CYPRINIDAE

Puntius paludinosus Peters

Three, 22 to 28 mm. to ends of broken caudals. In alcohol pale brown, with the iris, side of the head and axial band bright shining silvery white. At the caudal base a large ellipsoid black blotch with its longer diameter at the caudal base on the lateral line, and its length little greater than the diameter of the eye. Fins uniformly pale.

These specimens resemble my figure of *Barbus tsotsorogensis*[3] except that the black caudal blotch is sharply defined and the base of the dorsal fin is without black. *B. tsotsorogensis* is synonymized with the present species by Barnard 1948.

Eight, 36 to 40 mm. D. III, 6, with third simple ray spine like and serrated along its hind edge. A. III, 5. In alcohol color rather dark brown on back, sides of head and abdomen bright silvery white. An indistinct underlaid leaden axial band on side of tail and best defined posteriorly or on caudal peduncle, but without ending in a black subbasal caudal blotch. Vertical fins grayish and paired fins pale or whitish. Iris bright silvery white.

These specimens also show quite divergent scale structure from the scales shown by Wagenschieber's lithograph as published by Peters,[4] as the apical striae range from 7 to 9 and the basal striae are 2 to 9. The dorsal spine is similarly armed to that of Wagenschieber's drawing, except that it has fewer (12 to 14) denticles along its hind edge, he showing 21.

Puntius carpenteri new species Figures 1 to 4.

Depth 3⅛ to 3¼; head 3⅕ to 3⅖, width 1⅞ to 2. Snout 4 to 4⅖ in head, its tip level with lower part of pupil; eye 2¾ to 3, exceeds snout, subequal with interorbital; mouth small, little inclined and closed jaws even in front; apparently a single maxillary barbel each side, the maxillary reaching to opposite front edge of eye; lips thin, entire; interorbital broadly convex, width 2¼ to 3 in head; suborbitals narrow. Gill opening extends forward opposite middle of eye. Gill rakers 2 or 3 + 9 short points. Pharyngeal teeth 2, 3, 5 on each bone.

Scales 22 or 23 in lateral line to caudal base and 2 or 3 more on latter; 4½ scales above lateral line to dorsal base or origin, 2 below to ventral origin; 10 to 12 predorsal.

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[3] Ann. Transvaal Mus., vol. 16, pt. 2, 1935, p. 265, fig. 9. Tsotsoroga Pan; Makarikari depression, Kabulabula.

[4] Reise Mossambique, Zool., pt. 4, 1868, p. 51, pl. 11, fig. 1 (and insert scale).

D. III, 8, third simple ray spine like, with 20 or more antrorse and rather large denticles along its hind edge, fin height 1⅗ to 1 in head; A. III, 5, fin height 1¾ to 2; least depth of caudal peduncle 2⅕ to 2¼; caudal forked, length 3½ to 3⅗ in rest of fish; pectoral rays I, 10, fin 1⅕ to 1⅗ in head; ventral 1⅕ to 1¼, rays I, 6.

Color in alcohol brown above, pale to bright silvery white below. Black axial band from snout tip, also included or reflected on tip of mandible, and extends back to midcaudal base. Above or on back each scale exposure with darker blotch so arranged that 3 parallel longitudinal bands are formed. Top of head brownish. Along anal base and caudal peduncle on its lower edge, dark brown line. Iris, except as crossed by dark lateral band, whitish, with a silvery sheen. Above and along black axial lateral band and parallel, a broad silvered white band. Most specimens show sides of head and abdomen shining.

A.N.S.P., no. 71851. Kafue River, near Malabuka, Rhodesia. October 1946. Length 37 mm. Type.

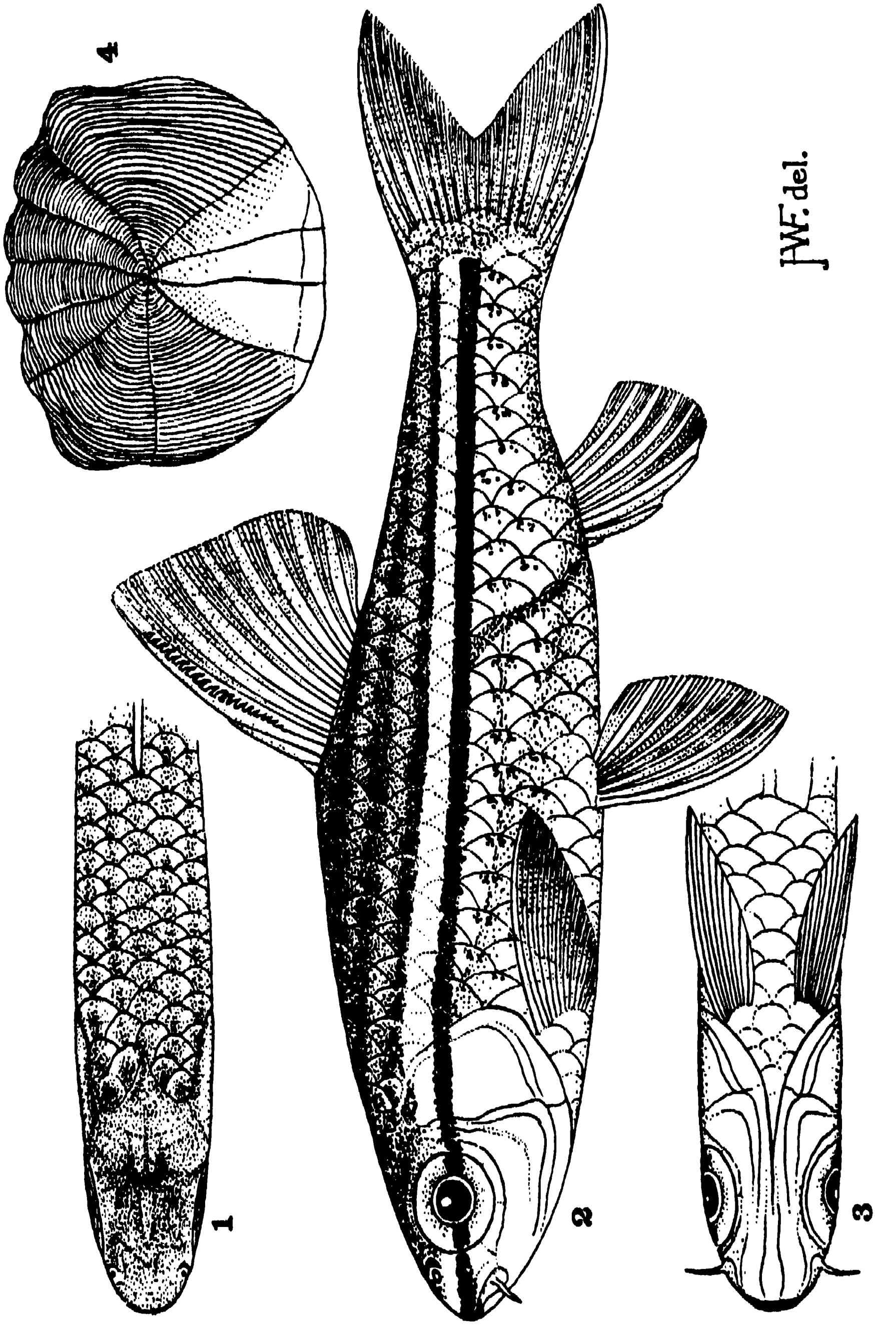
A.N.S.P., nos. 71852 to 71861. Same data. Paratypes. Length 18 to 37 mm. Although there are 145 other specimens, all within the same dimensions, many are now in poor preservation owing to their previously dried condition, so that I hesitate to attempt further details.

This species appears to be related to *P. paludinosus*, differing sharply in coloration and structural characters. The narrow black axial band or line extends around the end of the muzzle edging the front of the mandible, then back through the eye to end abruptly at the caudal base. Above are at least 3 distinct though less vivid dark to blackish parallel bands. From behind the upper edge of the eye, between the two lowest black bands, a silvered gray band is interposed, extending from the upper postorbital region to the base of the upper caudal lobe. In scale structure it approaches Wagenschieber's lithographic insert, though the radii on the scales are also variable, as I find several more or less on a number of scales examined. The armature of the dorsal spine is more elaborate and extends a little more subbasally. Owing chiefly to the condition of most of the specimens, I have not been able to discover more than a single pair of barbels, though possibly an anterior pair may be present.

(Named for Mr. William K. Carpenter.)

Puntius atromaculatus (Nichols and Griscom)

Twenty-two, 25 to 39 mm., most with broken caudals. The variation in the axial line of black spots is considerable, and in at least one specimen only the caudal blotch appears distinct. In all the specimens, however, the black spot at the front of the anal fin is distinct. The barbels are little evident or inconspicuous. One small specimen seems to have no prominent dark spots, though there is an obscure one at the anal base and another less evident at the front of the anal base.



Puntius carpenteri new species. Fig. 1.—Head above. Fig. 2.—Lateral view of type, 37 mm. long to end of broken caudal. Fig. 3.—Head below. Fig. 4.—Scale, 2 mm.

According to Barnard, the figures I have given of Angola specimens as *Barbus lujae* Boulenger[5] are variations of the present species, which he identifies as *Barbus radiatus* var. *barotseensis* Pellegrin[6]

CYPRINODONTIDAE

Epiplatys johnstoni (Guenther)

Three hundred twenty-four specimens, 15 to 40 mm. In this large series the majority of the specimens are small. The species is a modestly colored little fish, without any distinctive markings. In alcohol the general color is pale brown, paler to buff white to white with subdued silvery tints on the lower sides of the head and abdomen. Iris pale to whitish. Fins pale, light gray on dorsal and caudal. None of these specimens are as small as those I figured from Kabulabula, Bechuanaland.[7] All show at least more or less distinct scalation.

ANABANTIDAE

Ctenopoma multispinis Peters

Two, 24 and 26 mm., to ends of broken caudals. Ten transverse and slightly darker bands on body and a large black ocellus at the caudal base.

CICHLIDAE

Tilapia sparrmani A. Smith

One hundred seventy-eight specimens, 20 to 45 mm. In almost all there is usually a small dark subbasal spot on the caudal, with a larger black spot at the caudal base immediately in front. Often the transverse dark bands are emphasized or darkened as a black blotch where they pass over axially. Only four specimens have a large black blotch or ocellus on the last dorsal spines and first dorsal rays conspicuous, also the narrow dark transverse bands, 9 in number, are narrower than the pale interspaces and prominent.

FRESH-WATER FISHES OBTAINED IN FRENCH EQUATORIAL AFRICA IN 1948

On his second expedition in 1948 Mr. Carpenter collected a number of interesting natural history specimens in French Equatorial Africa for the Academy. The localities or stations given are as follows:

January 24 to 30.—Oka, 18 miles north of Eouo, Congo system. Here the stream is about 20 feet wide, and fast flowing in the Lembesse River basin, the altitude 1200 feet. The Lembesse is tributary to the Kouyou, an affluent of the Likouala which empties into the Congo at Mossaka.

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[5] Proc. Acad. Nat. Sci. Phila., 1930, fig. 6.

[6] Bull. Soc. Zool. France, vol. 45, 1920, p. 149.

[7] *Aplocheilus johnstoni* Fowler, Ann. Transvaal Mus., vol. 16, pt. 2, 1935, p. 277, fig. 14.

March 2.—Ubangui-Shari, near N'délé, Shari basin. A small stream visited was full of small prawn-like crustaceans. This stream was of a milky color, evidently due to the light clay soil which was common to the region. Altitude 1950 feet.

Aouk River from about 120 miles east of Fort Archambault, at 1250 feet altitude. Only one fish obtained, a large fresh-water puffer. Mr. Green reported seeing natives, on the Shari River, with this species of about 18 inches in length.

March 13.—Bahr Sara, a tributary of the Shari River near Fort Archambault, altitude 126 feet. Mr. Green noticed that the catfish (*Clarotes*) appeared to give off electric impulses when he removed them from the net. Larger fishes were attacked by other fishes before they could be taken out of the net. Also the larger fish would leap six or eight feet clear of the water as the net was pulled in.

April 5.—A small lake 100 by 50 feet was visited at the Oasis of Fada, Ennedi, in the Territory of Chad, the altitude 1771 feet. Water beetles and fishes were numerous. This pool had no surface entrance or exit.

Altogether 266 specimens were collected in 1948, representing 26 species, of which 16 appear to represent new species or subspecies, and two new genera. I feel grateful to Mr. Carpenter for the opportunity to study and report on this interesting collection. Likewise thanks are due to Mr. Harold T. Green, Curator of Exhibits at the Academy, who accompanied Mr. Carpenter and cared for the collection of fishes.

CLUPEIDAE

Stolothrissa lembesseensis new species Figures 5 to 8.

Depth 4 to 4¼; head 3¼ to 3⅓, width 2 to 2¼. Snout 3½ to 4 in head measured from snout tip, which is level with the upper edge of the pupil; eye large, diameter 2⅝ to 2⅔ in head, greatly exceeds snout or interorbital and without distinct adipose lids; maxillary 2¼ to 2⅓ in head, reaches to below front of eye; mouth rather large, closed lower jaw slightly protruded in front and mandibular rami moderately high inside mouth; teeth uniserial in jaws, simple, curved and conic, about 8 to 10 above and 20 in the mandible with the anterior largest, graduated smaller posteriorly; interorbital narrowed forward, convex. Gill rakers 6 + 12, slenderly and sharply pointed, lanceolate.

Scales 35 or 36 + 3 in axial lateral series; 10 transversely; 10 predorsal. Abdominal scutes 10 + 9, anterior inconspicuous and posterior prominent. Scales caducous, many having fallen.

D. II, 10, fin origin little nearer snout tip than caudal base, when depressed reaches 2¼ to 2⅓ times to caudal base; A. II, 15, inserted entirely behind dorsal, fin rather low; least depth of caudal peduncle 3 to 3⅛ in total head length; pectoral low, rays 10 or 11, fin reaches 1½ to ventral; ventral subequal with pectoral, rays I, 6, inserted little behind dorsal origin.

Color in alcohol pale brown, sides and below paler to whitish. Pale or subdued silvery white band axially on side but little defined. Snout above and top of head with dark brown. Each scale exposure on back with dark transverse bar or line. Dark spot at base of each anal ray on edge of body. Fins all more or less pale, with dorsal and anal tinged grayish.

A.N.S.P., no. 71862. Oka, Congo system, French Equatorial Africa. Jaunary 1948. Length 40 mm. to ends of broken caudal lobes. Type.

A.N.S.P., nos. 71863 to 71872. Same data as type. Length 29 to 44 mm. Paratypes.

Appears to be related to *Stolothrissa tanganicae* Regan,[8] which would differ in its more slender body (in specimens 80 to 90 mm.), smaller head, snout longer than eye which is smaller, maxillary not or barely reaching vertical from front edge of eye, lower gill rakers 40 to 42, scales 45 in lateral series, 13 transversely, and more preventral scutes.

Though the genus *Stolothrissa* does not appear to have been reported previously outside of Lake Tanganyika, the present specimens establish it in the Congo basin. Poll[9] has figured a fish showing venules on the head and shoulder, scarcely evident in my specimens, besides exhibiting an entirely different physiognomy. His largest recorded specimens are given as 95 mm.

(Named for the Lembesse River.)

PHRACTOLAEMIDAE

PHRACTOLAEMUS Boulenger

Body elongate, subcylindrical, little compressed and edges all rounded. Head unusually small, depressed. Snout short, wide. Eye small, advanced, lateral. Mouth small restricted orifice supra-terminally on snout, with the broad mandible protruded forward. Moderately short barbel with end little obtuse, contains terminal front nostril, and hind nostril posteriorly basal. Scales large, little smaller on tail posteriorly and on caudal base. Ventrals without axillary scale. Lateral line complete. Predorsal scales encroach on posterior part of head about last third of its length. Chest and breast with large scales like those on belly. Pearl organs 4 laterally and bordering eye. Four rows of pearl organs on each side of caudal peduncle. Most scales on caudal peduncle with row of fine bordering points or tubercles on scale exposures. Dorsal inserted postmedially, rays flexible. Anal inserted much nearer caudal base than to dorsal base, fin small. Caudal small, rounded. Pectoral small, short, broad. Ventral inserted slightly premedially. Type: *P. ansorgii* Boulenger.

An interesting fish, unique in its combination of characters. Its elongated and comparatively slender body, small and peculiar head, small lateral

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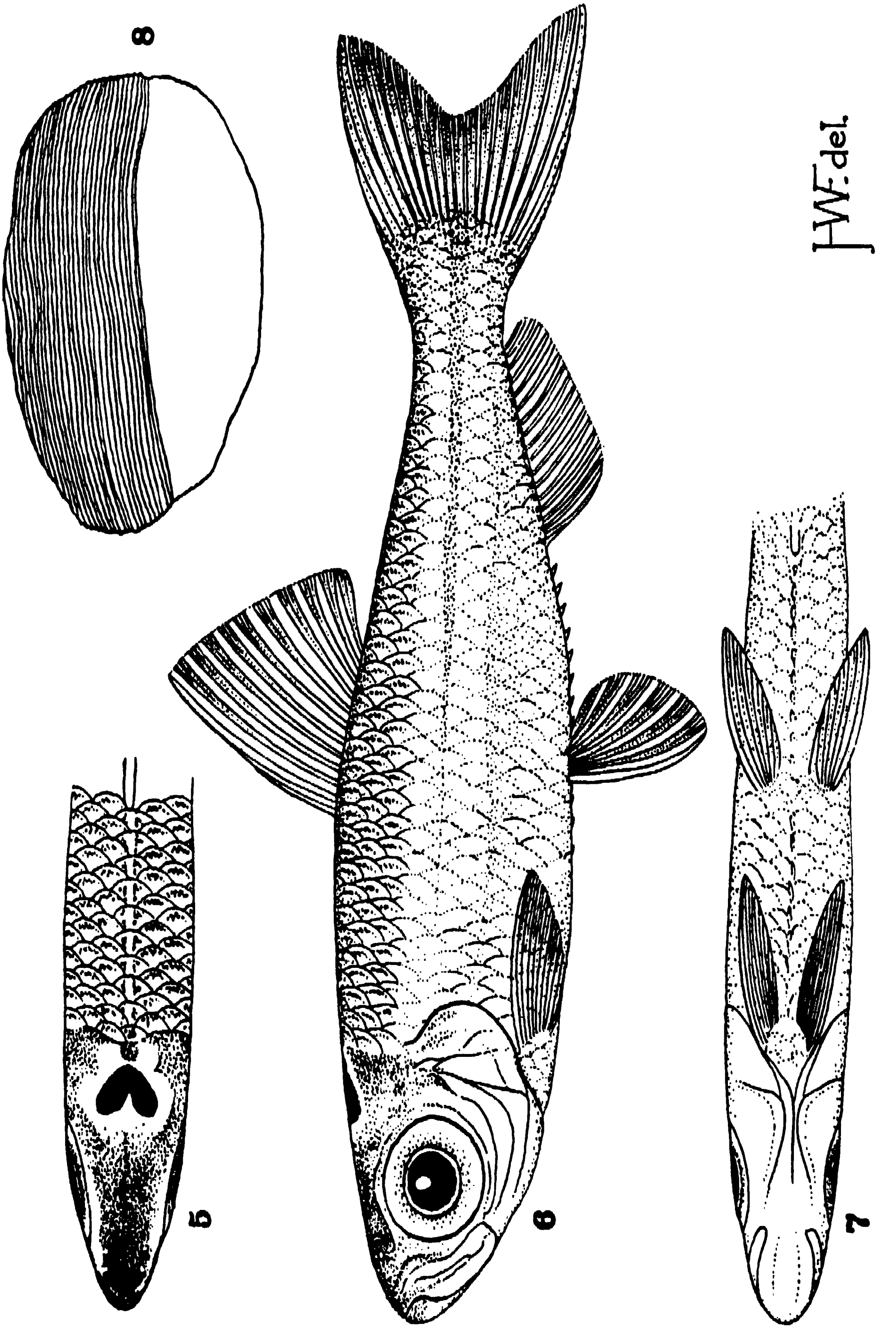
[8] Ann. Mag. Nat. Hist., ser. 8, vol. 19, 1917, p. 206, figs. 2 [no.] 2 (outline head). Vua and Ndauvie, Lake Tanganyika.

[9] Ann. Mus. Congo, Z. (1)4, fasc. 3, 1946, 166. figs. 3-4. L. Tanganyika localities.



Stolothrissa lembesseensis new species. Fig. 5.—Head above. Fig. 6.—Lateral view of type. Fig. 7.—Head below. Fig. 8.—Scale. 2 mm.

eyes, the supraterminal and restricted mouth, rather conspicuous barbels, large scales, small fins, complete lateral line and the elaborate and unusual pearl organs, are not met with in any of the numerous subfamilies or genera of cyprinoids in such combination.

Phractolaemus spinosus carpenteri new subspecies Figures 9 to 14.

Depth $4\frac{1}{3}$ to $5\frac{1}{2}$; head $4\frac{3}{4}$ to $7\frac{1}{2}$, head width $1\frac{1}{6}$ to $1\frac{1}{3}$ in total head length. Snout length (in profile) measured to front end of mandible $2\frac{7}{8}$ to $3\frac{1}{8}$ in head; eye 6; interorbital $1\frac{1}{8}$ to $1\frac{5}{8}$ in total lateral profile of head. Barbel long as mouth width, which is $3\frac{1}{4}$ to $3\frac{3}{4}$ in head. Gill opening lateral, cleft equals mouth width.

Scales 34 to 47 + 2 or 3 in lateral line; 4 above to dorsal origin, 4 below to ventral origin, 4 below to anal origin; 19 predorsal. Only caudal fin with basal band of small scales, 3 or 4 in the transverse series. In addition to the ocular paired tubercles and those on the caudal peduncle which are spinigerous, the basal portions of the caudal rays and the terminal portions of the anal rays are minutely spinescent. Scales with 3 basal radiating striae forming 4 marginal lobes; little beyond middle meeting transverse striae which give off 9 parallel apical striae, between which are many fine parallel less conspicuous striae, these appearing to replace the numerous fine basal circuli.

D. ii, 3, i, depressed fin reaching $1\frac{7}{8}$ to $2\frac{1}{8}$ times to caudal base; A. ii, 1, iii or ii, I, ii; ii, 2, i; ii, 2, ii, depressed fin reaching 1 to $1\frac{1}{3}$ times to caudal base; caudal rounded behind, fin $1 + \frac{1}{6}$ times head; pectoral rounded, with scaleless base, rays i, 16, i or ii, 14, ii; ii, 9, iv, length $1\frac{1}{8}$ to $1\frac{1}{3}$ in total head length; ventral 1 to $1 + \frac{1}{8}$ times, rays i, 4, i.

Color in alcohol very dark to blackish brown, with general black appearance, the tubercles of the tail of the ornamented fish appearing pale or whitish, though its sex organs appear to be little developed. Each scale with a black basal blotch. Iris slate black. Fins with rays brown and fin membranes paler, those of the type with ends posteriorly all light to whitish on caudal.

A.N.S.P., no. 71873. Eight miles south of Oka, Congo system, French Equatorial Africa. January 2. Type. Length 123 mm.

A.N.S.P., nos. 71874 and 71875, also 71899. Same data. Paratypes. Length 77 to 97 mm. All from a small brook in a swamp.

These specimens appear to represent a new subspecies, distinct from *P. spinosus* Pellegrin,[10] though with similar secondary sexual characters highly developed in our tuberculated type specimen. Boulenger states for *P. ansorgii* that "on the caudal region the scales of the lateral line and those in the series above it may bear a central tubercle." Several of these are shown on the figure given by Boulenger, but they do not appear as pointed or spinigerous, such as those found on *P. spinosus carpenteri*. Boulenger's figure, if it is to be trusted, differs decidedly in other respects as each scale is shown with a transverse dark band on each scale exposure,

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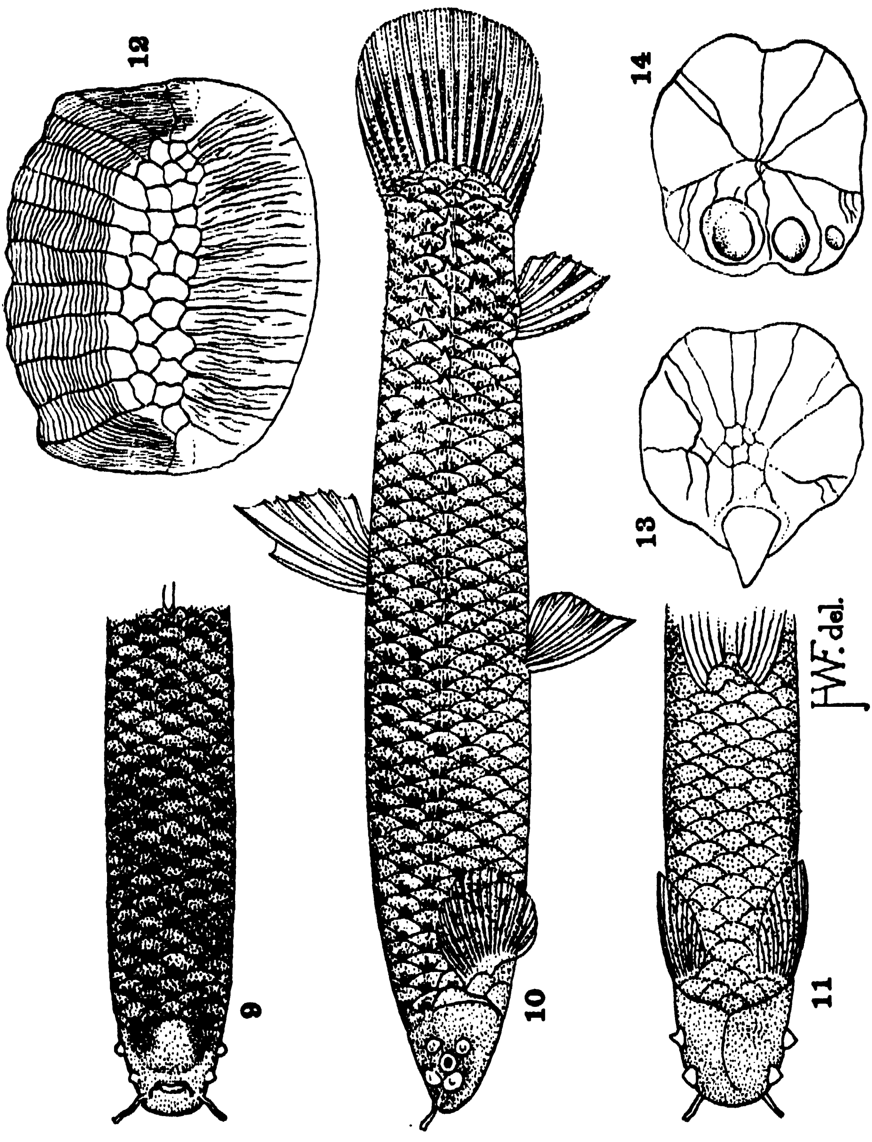
[10] Compt. Rend. Acad. Sci. Paris, vol. 180, 1925, p. 549. Sangha.



Phractolaemus spinosus carpenteri new subspecies. Fig. 9.—Head above. Fig. 10.—Lateral view of type Fig. 11.—Head below. Fig. 12.—Scale, 6.5 mm. Figs. 13 and 14.—Scales from lateral line, drawn smaller.

thus the color pattern resulting in a very different design. His details of the caudal fin are also at variance, as the auxillary small basal scales are shown extending out to near the middle, or even over the entire basal half of the caudal fin. His description gives the dorsal rays 6, the first 4 rays simple and the others usually bifid. This does not agree with the figure which shows only 2 anterior simple dorsal rays. As he mentions "anal 6, similar to dorsal" the same erroneous statement applies.[10a] Pellegrin[11] repeats Boulenger's error as he gives "La dorsale a ses 4 premiers rayons simples, les 2 autres bifides", his figure showing them II, 4; "l'anale est semblable à la dorsale", but according to the drawing that fin shows II, 3. He gives the colors as olive and the fins crimson.

P. spinosus Pellegrin is based on 6 specimens 58 to 120 mm. in length and so far as the description unaccompanied by any figures permits, it appears closely related. *P. spinosus spinosus* would not only differ markedly in coloration, as it is described as uniformly olive brown, but also in a larger eye (4¾ to 5¼ as compared with 5½ to 6 for *P. spinosus carpenteri*).

It follows that *P. carpenteri* differs chiefly in the arrangement and presence of its black spots on the scales, and in other details of the coloration, besides the scalation of the caudal fin and the fin proportions.

(For Mr. William K. Carpenter.)

TETRAGONOPTERIDAE

Alestes nurse (Rueppell)

Four, 33 to 87 mm. Bahr Sara, in tributary of Shari River near Fort Archambault. March 13. A. III, 11 to III, 13. Black blotch reflected out on median caudal rays. Smallest specimens without black basal caudal blotch or the post-scapular spot. General color brownish, with an ill-defined lateral axial silvery band.

Alestes macrolepidotus (Valenciennes)

One, 225 mm. Bahr Sara, March 13.

Depth 3⅔; head 3⅝. D. II, 8; A. III, 13; P. I, 13; V. I, 7. Scales 23 + 2 in lateral line; 4½ above to dorsal origin, 2 below to ventral origin. Gill rakers 10 + 17, finely lanceolate, less than half of gill filaments. Color in alcohol brown, paler or inclining to whitish below. Scales on back all with darker edges. Fins uniformly dull brown. Inner or hind caudal edge narrowly dark gray.

Micralestes acutidens (Peters)

One, 39 mm. Oka, Congo system. January. Depth 3¾; head 3¾, width $2\frac{1}{10}$. D. II, 6. A. II, 14. Scales (pockets) 24 in lateral axial series to caudal base.

Micralestes stormsi Boulenger

One, 25 mm. Bahr Sara, March 13. Teeth in jaws tricuspid. No maxillary teeth. In alcohol general color pale yellowish brown. Iris dark gray. Edge of back gray. Diffuse axial gray band on side, most distinct on tail and side of caudal peduncle. Caudal pale, ends grayish.

[10a] Cat. Fresh-water Fishes Afr., vol. 1, 1909, 168, fig. 133. Type.

[11] Poiss. Afr. Occid., 1923, 88, fig. 19.

This interesting immature stage does not appear previously noticed. The specimens lack the lateral line and the adipose fin.

Petersius bahr-sarae new species Figures 15 to 18.

Depth $3\frac{2}{5}$; head 3, width $2\frac{1}{4}$. Snout (in profile) 6 in head as measured from snout tip, which is level with upper part of pupil; eye large, greatly exceeds snout, and greater than front part of interorbital, diameter 3 in head as measured from snout tip; maxillary extends to below front edge of eye, length $2\frac{1}{2}$ in head from snout tip, toothless; upper teeth biserial, larger ones at least tridentate with 10 in outer series; lower teeth uniserial, 10 in number, tridentate and like upper median teeth largest; interorbital width anteriorly $3\frac{1}{10}$ in head from snout tip; suborbitals broad, covering cheek. Gill opening extends forward to nearly opposite front of eye.

Scales 32 in axial lateral series to caudal base and 2 more on latter; no lateral line; 9 scales transversely above anal origin to dorsal base; 13 predorsal. Scales along anal base slightly overlap fin base.

D. III, 7, origin of fin midway between caudal base and front edge of eye, fin height $1\frac{1}{3}$ in total head length; no adipose fin; A. III, 17, inserted below hind part of dorsal fin base, its own fin base $1\frac{1}{4}$ in total head length; caudal peduncle length subequal with its depth, which is $2\frac{3}{5}$ in total head length; caudal forked, lower lobe longer, fin $3\frac{1}{8}$ in rest of fish; pectoral placed low, rays I, 9, reaches over ventral, length $1\frac{1}{6}$ in total head length; ventral inserted slightly before dorsal origin, fin length $2\frac{1}{2}$ in total head length rays I, 7.

Color in alcohol pale or dilute yellowish brown. Scales on back above very slightly edged with dark gray. An axial dark gray line on side of body, most distinct along tail and caudal peduncle, also slightly diffuse grayish each side. Abdominal region with dark pigment dots, defining more or less an arched translucent strip down to front of anal fin. Iris dark gray, with traces of silvery. Fins mostly pale or translucent to dilute brownish, with a slight longitudinal band on each caudal lobe.

A.N.S.P., no. 71876. Bahr Sara, Shari River basin. March 13. Length 33 mm. Type.

Only the type obtained. I assume it belongs in *Petersius* as I have been unable to discover an inner pair of mandibulary teeth. It does not appear to be any known species, or any of the larger scaled *Micralestes*. From *P. brevidorsalis* Pellegrin[12] this species differs in its large scales (25) and only 13 or 14 branched anal rays.

(Named for Bahr Sara, the type locality.)

Microstomatichthyoborus bashforddeani Nichols and Griscom

Two, 37 and 53 mm. Oka, Congo system. January. The larger one agrees with my figure of a specimen 60 mm. long from Ft. Sibut, Ubangi Shari.[13] Differences are a slightly longer maxillary, but it does not reach

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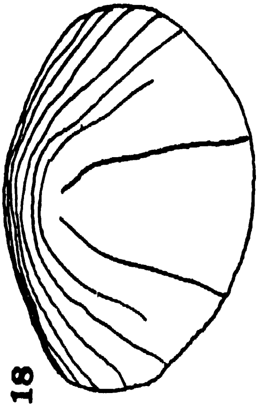
[12] Bull. Soc. Zool. France, vol. 46, 1921, p. 49. Gribingui, L. Chad basin.

[13] Proc. Acad. Nat. Sci. Phila., 1936, p. 263, fig. 15.



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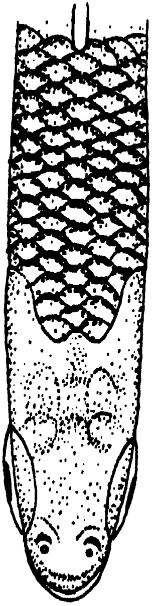

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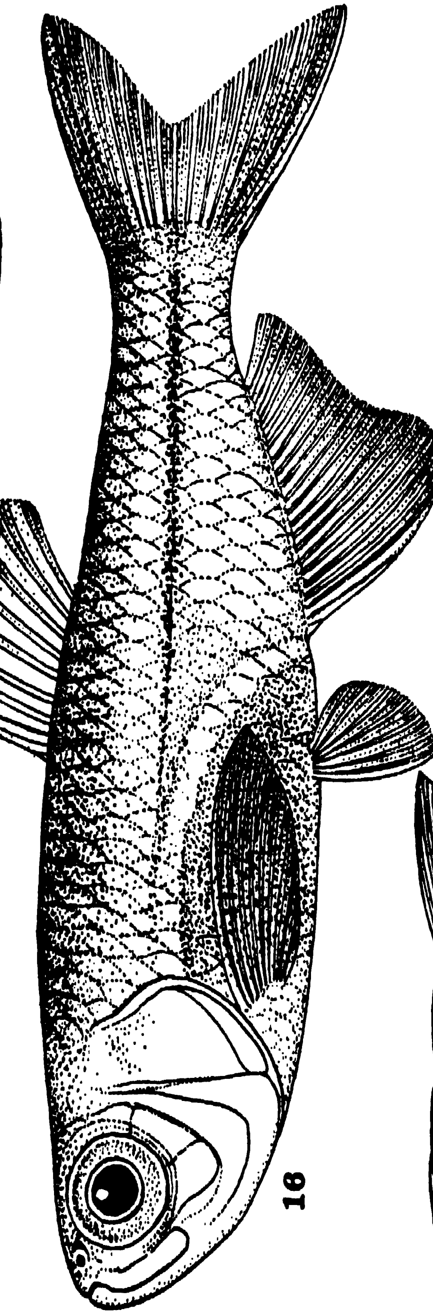

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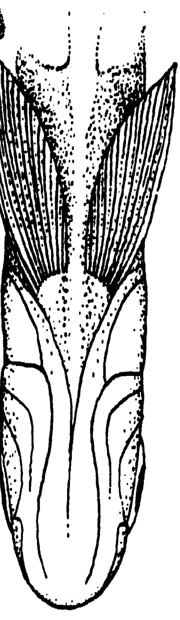

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Petersius bahr-sarae new species. Fig. 15.—Head above. Fig. 16.—Lateral view of type. Fig. 17.—Head below. Fig. 18.—Scale, 2 mm.

to opposite the front of the eye, the closed lower jaw distinctly shorter than the upper so that the snout protrudes a little in front, larger eye 3 in head, short pectoral reaches 2¼ to ventral and scales about 72 in the lateral line, though only the first 14 bearing tubes. This specimen also differs somewhat in color as the body has a pale narrow supra-axial line from the upper part of the gill opening to the caudal base slightly above the middle. This divides the dark brown color of the back from the much wider brown lateral band, also from the upper gill opening to the caudal base, where it resolves into a narrow blackish triangle pointed to the crotch of the caudal fin, but not quite reaching to the end of the median caudal rays. Blackish median blotch close before anal fin, another on body at base of anal anteriorly and finally, blackish marginal streak along lower edge of caudal peduncle. The dorsal and caudal are with black markings as shown on my drawing.

The smaller specimen shows the dark lateral band marked with darker blotches.

BATHYAETHIOPS new genus

TYPE.—*Bathyaethiops greeni* new species

Body deeply ellipsoid and well compressed with edges all convex. Head moderate, compressed. Eye large, not veiled with adipose lids. Mouth superiorly terminal. Teeth with median cusp large and several smaller ones each side. Suborbitals cover cheek. Air bladder forming evident transparency above space between ventrals and anal fins. Scales large, small as converging on caudal peduncle. Lateral line complete, decurved. Ventral axil with pointed scale. Dorsal fin inserted slightly behind ventral origin, or dorsal origin median in standard length. Anal begins behind dorsal base, fin base as long as head. Pectoral nearly reaches ventral.

Distinguishable by its greater body depth, deeply ellipsoid in contour, free eyes without adipose lids, the elevated entire dorsal fin, supero-terminal mouth and peculiar pattern of darkened coloration.

(*βαθὺς* deep + *αἴθίοψ* burned or glowing.)

Bathyaethiops greeni new species Figures 19 to 23.

Depth 2⅓ to 3½ (young); head 3⅔ to 3⅚ (young), width 1¾ to 2⅓. Snout short, broad, length in profile 4⅙ to 4¾ (young) in head measured from snout tip, its front end level with upper edge of pupil; eye 2⅙ (young) to 2⅓; maxillary vertical, toothless, extends down to level of, or to a little below, lower edge of eye; teeth septemdentate, apparently biserial above and uniserial below; no inner third row above or lower inner second row made out; broad bony suborbitals entirely cover cheek. Gill rakers 6+12, finely lanceolate, slender, as long as gill filaments or ⅓ of eye.

Scales 33 or 34+2 or 3 in lateral line; 8½ above to dorsal origin, 3½ below to ventral origin; 13 or 14 predorsal. Narrow band of small scales along front base of anal. Scales with 1 to 4 basal radiating striae; circuli fine.

D. III, 8, fin elevated, when depressed not quite reaching adipose fin; A. III, 21, fin base subequal with head; caudal deeply forked, length 2⅘ to 3 in rest of fish; pectoral rays I, 15, length 1⅕ to 1⅗ in total head length; ventral rays I, 5, fin length 1½ (young) to 1+⅕ times head in adult.

Color in alcohol light brown, scarcely paler below. Edges of back dark blackish brown. Iris pale gray, apparently whitish when fresh. Along side axially an underlaid pale indefinite silvery white band. Along this a black posthumeral blotch less than eye diameter and behind third scale from head, followed by 5 slightly inclined blackish gray bars, then a larger one and finally a large black blotch below adipose fin, but not quite reaching narrow dark edging of back, but below it merges with the black basal line of the anal fin in the adult. From edge of dorsal and hind edge of basal squamous area of caudal, it is delineated by narrow black band. In the young the black caudal blotch does not extend to the hind base of the anal fin, but is reflected out on the caudal fin basally, then terminally pale on the lobes. Vertical fins largely pale grayish with the outer front anal edge narrowly black, but only as a black submargin in the young. Paired fins grayish.

A.N.S.P., no. 71877. Oka, Congo system. January 24. Length 52 mm. Type.

A.N.S.P., nos. 71878 to 71887. Same data. Length 15 to 50 mm. Paratypes.

Distinctions for this species are included in the preceding generic account. Besides the types listed above, there are also 39 other specimens with the same data, and their size is included in the dimensions given for the paratypes.

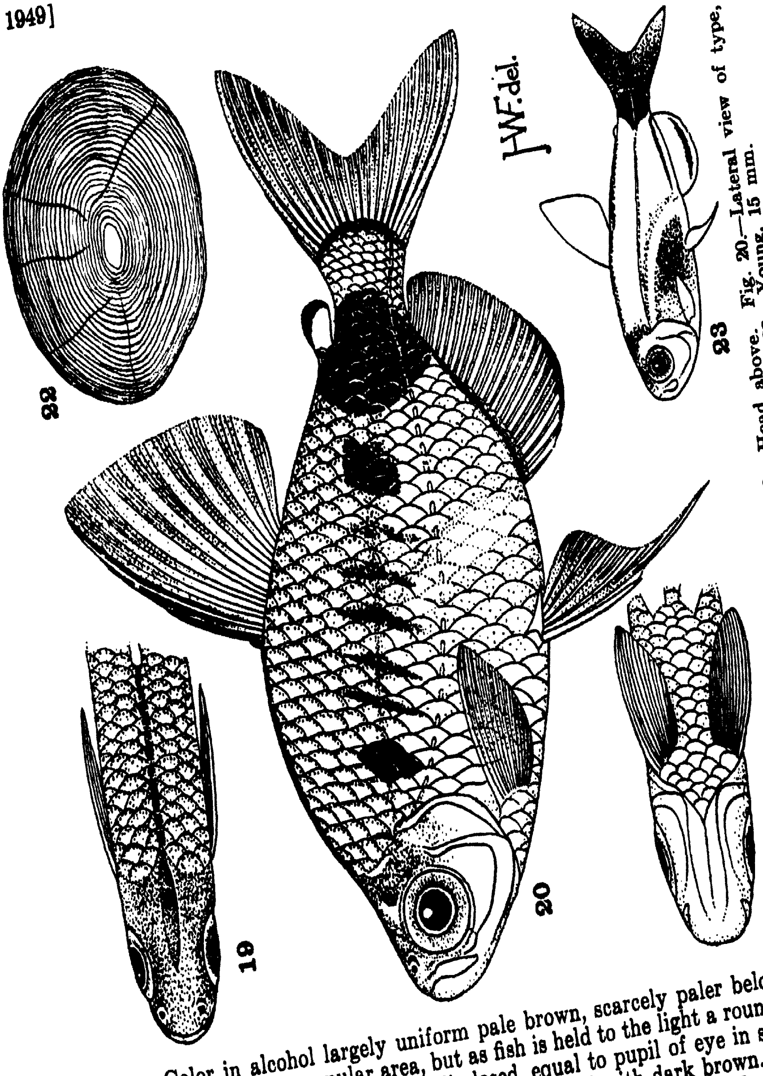
(Named for Mr. Harold T. Green.)

Nannocharax shariensis new species Figures 24 to 27.

Depth 3¾ to 4⅕; head 3⅓ to 3⅗, width 1⅘ to 2. Snout (in profile) 4 to 4¾ in head, tip level with eye center; eye large, not reaching upper profile of head, diameter 2¾ to 2⅘ in head, exceeds snout, 1 to 1⅕ in interorbital; maxillary reaches below hind nostril but not quite to front of eye, length 4 in head; mouth terminal, closed jaws about even in front; teeth small, largely uniform in front and graduated smaller in jaws posteriorly, most appear conic, more or less slender and little curved, some of larger ones little bifid; maxillary toothless; interorbital broadly convex, width 2⅓ to 2¾ in head. Gill opening extends forward to nearly opposite middle of eye. Gill rakers 4 + 7, short, slender, lanceolate, less than gill filaments.

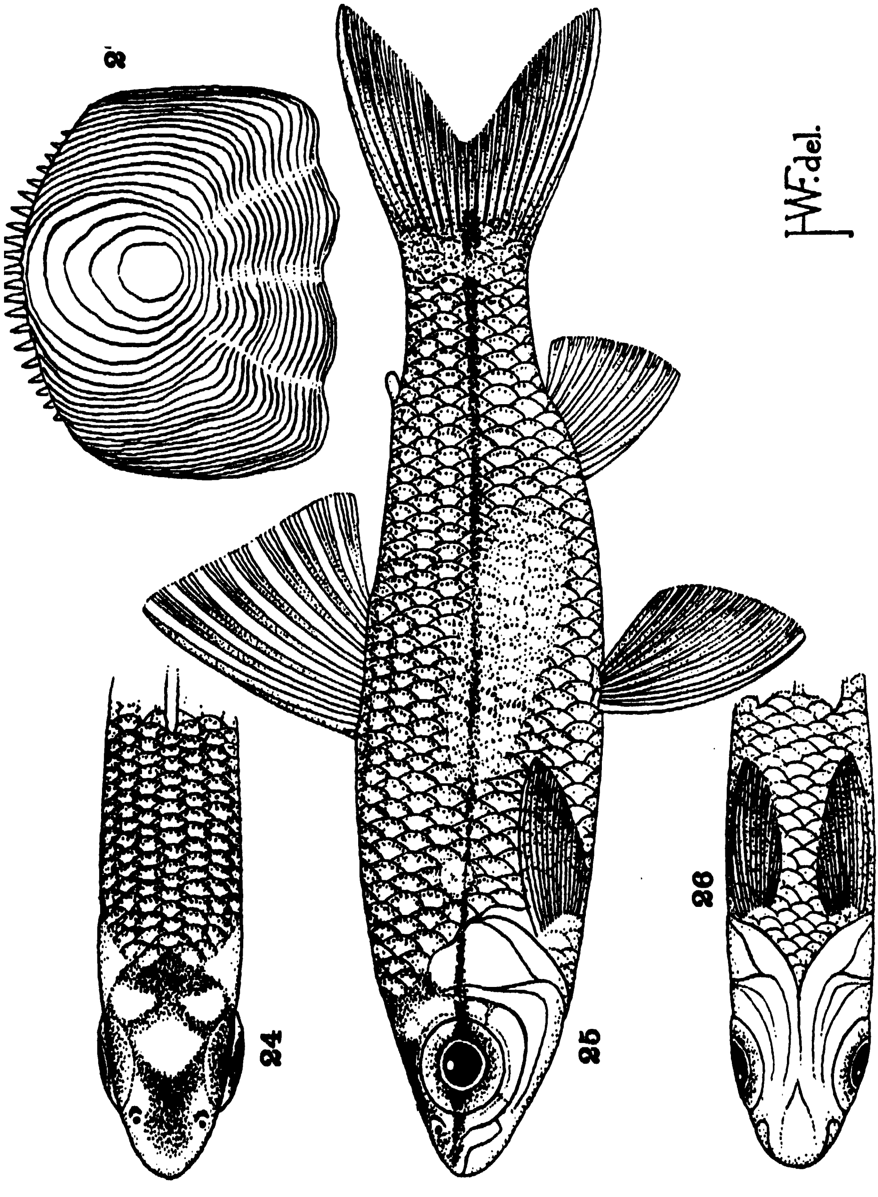
Scales 30 to 35 + 3 in a median lateral series; lateral line but feebly developed as extended over first 15 to 18 scales, tubes small and little evident; 16 scales transversely between dorsal and ventral origins; 13 to 15 predorsal. Of fins, only caudal with a few small basal scales. Axillary ventral scale small. On body, scales all more or less uniform in size and disposed in even longitudinal rows.

D. III, 8 to III, 10, I, fin height $1\frac{1}{10}$ to 1⅕ in head; adipose fin small; A. III, 7 or III, 8, fin height 2 to 2⅕; least depth of caudal peduncle 2⅕ to 2¼; caudal well forked, length 2½ to 3⅓ in rest of fish; pectoral 1¼ to 1½ in head, rays I, 12; ventral 1¼, to 1½ in head, rays I, 8.



Bathyaethiops greeni new species. Fig. 19.—Head above. Fig. 20.—Lateral view of type, 52 mm. Fig. 21.—Head below. Fig. 22.—Scale, 3 mm. Fig. 23.—Young, 15 mm.

Color in alcohol largely uniform pale brown, scarcely paler below. On body brown post-scapular area, but as fish is held to the light a round transparency or pseudotympanum is disclosed, equal to pupil of eye in size. On the back above some of scales have edges dusted with dark brown. A narrowed blackish lateral band around tip of snout, through eye back to caudal base, where it is detached as a black basal caudal spot. Iris gray. Head with some brown markings above. Dark bands are formed at scale junctures longitudinally on back and thus all are parallel with narrow black axial band.



Nannocharax shariensis new species. Fig. 24.—Head above. Fig. 25.—Lateral view of type. Fig. 26.—Head below. Fig. 27.—Scale, 2 mm.

A.N.S.P., no. 71888. Ubangui-Shari, near N'délé. March 2. Length 33 mm. Type.

A.N.S.P., nos. 71889 to 71898. Same data. Length 20 to 32 mm. Paratypes. Also 39 other specimens, all with same data and within same body dimensions.

Differs from *N. parvus* Pellegrin, as shown in Boulenger's figure of the type,[14] in having its maxillary reaching opposite the front of eye. That figure also shows a different lateral black band which is continuous and broader than the pupil; moreover in *N. shariensis* it is interrupted at the caudal base to form a detached black spot on the base of the caudal, but this is not continued out over the median caudal rays.

(Named for the Shari River.)

CYPRINIDAE

Puntius okae new species Figures 28 to 32.

Depth 4; head $3\frac{1}{2}$, width $1\frac{3}{8}$. Snout $3\frac{1}{2}$ in head, obtuse, convex both over surface and in profile and its front end level with front edge of eye; eye $2\frac{1}{8}$ in head, close to upper profile of head; mouth cleft low, subhorizontal, reaches to below front of eye, and closed lower jaw much shorter than overhanging upper jaw; barbels 4, front pair little longer and all less than eye; interorbital $3\frac{1}{8}$ in head, low, convex. Gill opening lateral, extends forward to about opposite hind pupil edge. Suborbitals all narrow. Gill rakers 2 + 8, short rudimentary tubercles. Right pharyngeal teeth 5, 3, 1, ends pointed and little hooked.

Scales 19 + 2 in lateral line; $3\frac{1}{2}$ above to dorsal origin, 2 below to ventral origin; 7 predorsal. Of fins, only caudal base with band of small scales, all smaller than on body. Apparently ventral without pointed axillary scale. Scales with 12 radiating striae, of which 4 are basal.

D. II, 8, origin of fin slightly nearer snout tip than caudal base, simple rays slender, firm, entire and fin height equals head; A. III, 5, fin height $1\frac{3}{8}$ in head; caudal well forked, its length 3 in rest of fish, and fulcra well developed; least depth of caudal peduncle $2\frac{1}{10}$ in head; pectoral $1\frac{1}{3}$, rays I, 13; ventral $1\frac{1}{3}$, rays I, 7.

Color in alcohol pale brown generally, more or less uniform. Iris dark grayish, evidently silvery white in life. A subdued pale, ill-defined whitish axial band, contrasted with silvery lateral color, extends from head to base of caudal. On back most of scales show dull brown transverse bar on each scale exposure. Also many of scales on back have a dark blotch at the base of each scale pocket. Fins pale to transparent. Intestines show through walls of abdomen with more or less dark grayish.

A.N.S.P., no. 71900. Oka, Congo system. January 1948. Length 40 mm. Type.

Only the type secured. It approaches *Barbus miolepis* Boulenger[15] in general configuration, its type of coloration, the high dorsal fin, larger scales, small basal caudal scales and fin arrangement. It differs markedly in an entirely dissimilar contour of the head, owing chiefly to the overhanging convex snout with the mouth inferior, the front pair of barbels

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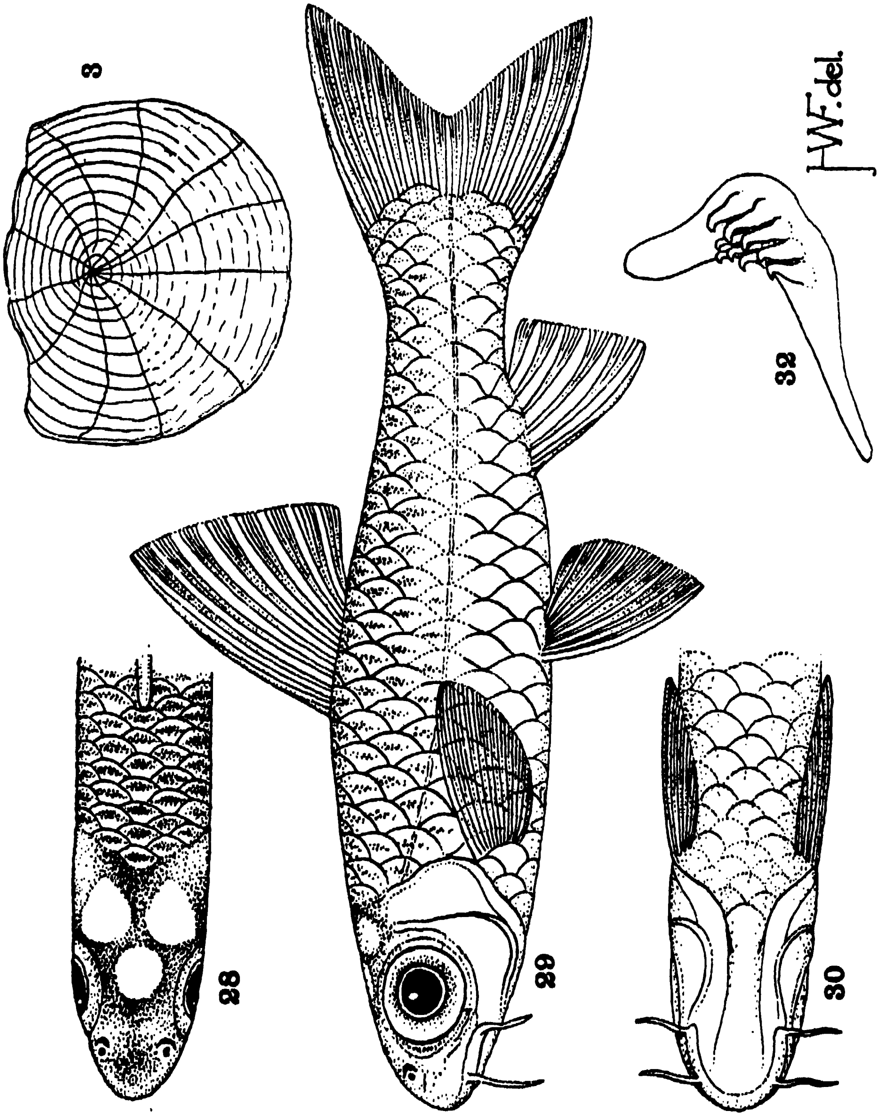
[14] Cat. Fresh water Fishes of Africa, vol. 1, 1909, p. 281, fig. 214.

[15] Cat. Fresh water Fishes of Africa, vol. 2, 1911, 141, fig. 117. Type. Yembe R. at Bansyville, Ubangi.



Puntius okae new species. Fig. 28.—Head above. Fig. 29.—Lateral view of type. Fig. 30.—Head below Fig. 31.—Scale, 2 mm. Fig. 32.—Right pharyngeal.

longer, mouth terminal and the anal fin closer to the caudal base. Boulenger's unsigned figure shows the front and apparently only simple dorsal ray (?) entire, while his description says, " last simple ray strong, bony, serrated, nearly as long as head." He also says, " Scales radiately serrated " and, " a blackish lateral band from gill cover to root of caudal," while the figure displays a large and conspicuous black vertical bar close behind the head and an axial series of 20 black spots, one at base of dark scale exposure and imposed as a pale or whitish axial band.

Barbus dolichosoma Nichols and Griscom[16] resembles Boulenger's species somewhat, but is figured with a greatly lower dorsal fin, a much longer snout, the 2 anterior simple dorsal rays subequally long, entire and both exceeding the other dorsal fin rays, more advanced ventral fin and maxillary not reaching below the front of the eye. The " black bar behind the opercle " is very suggestive of *B. miolepis*, and the rather indistinct small circles shown on the figure given by Nichols and Griscom on the side of its snout and infraorbital region reveal scars of a spawning fish.

(Named for the type locality Oka.)

Puntius syntrechalepis new species Figures 33 to 37.

Depth 4⅒; head 3⅓, width 2. Snout obtuse, convex, tip level with center of eye, length 5 in head; eye large, close to upper profile, length 2⅜ in head; mouth cleft short, but little inclined from horizontal, closed lower jaw slightly included; maxillary short, not quite reaching eye; maxillary barbel 1½ in eye; suborbitals form narrow flange around eye; opercle smooth; bony interorbital width 5 in head, low, little convex. Gill opening moderate, extends forward opposite hind edge of preopercle. Gill rakers 3 + 8 short points, rather robust. Right pharyngeal teeth 5, 4, 3, little hooked, slender.

Scales 23 + 2 in lateral line; 2½ above to dorsal origin, 2½ below to ventral origin; 8 predorsal. Axial ventral scale moderate or short. Scales converging smaller on tail posteriorly and on caudal peduncle. Lateral line axial, complete, tubes simple.

D. II, 9, second simple ray flexible, entire, long as head; A. III, 5, simple rays flexible with third about 2 in head; least depth of caudal peduncle 2⅛; caudal forked, lobes pointed, length 3¼ in rest of fish; pectoral rays I, 10, fin 1⅓ in head; ventral 1⅓, rays I, 6.

Color in alcohol light brown, little paler below. Scales on back and sides all appearing as if edged with dark gray, due to dark or minute pigment dots showing through close before overlapping scale margins. Iris gray, apparently whitish in life. Fins uniformly pale or whitish, with scales at caudal base deeper brownish.

A.N.S.P., no. 71901. Oka, Congo system. January 24. Length 28 mm. Type.

Only the type obtained. It resembles *Clupeobarbus* Fowler[17] in its large scales, high dorsal fin, reduced gill rakers, scale structure and short maxillary. Although the lateral line scale exposures are larger than those of the scales adjacent, they are not nearly so contrasted as in the genotype *Barbus kemoensis* Fowler. This approaches the scalation of *B. bomokandi*

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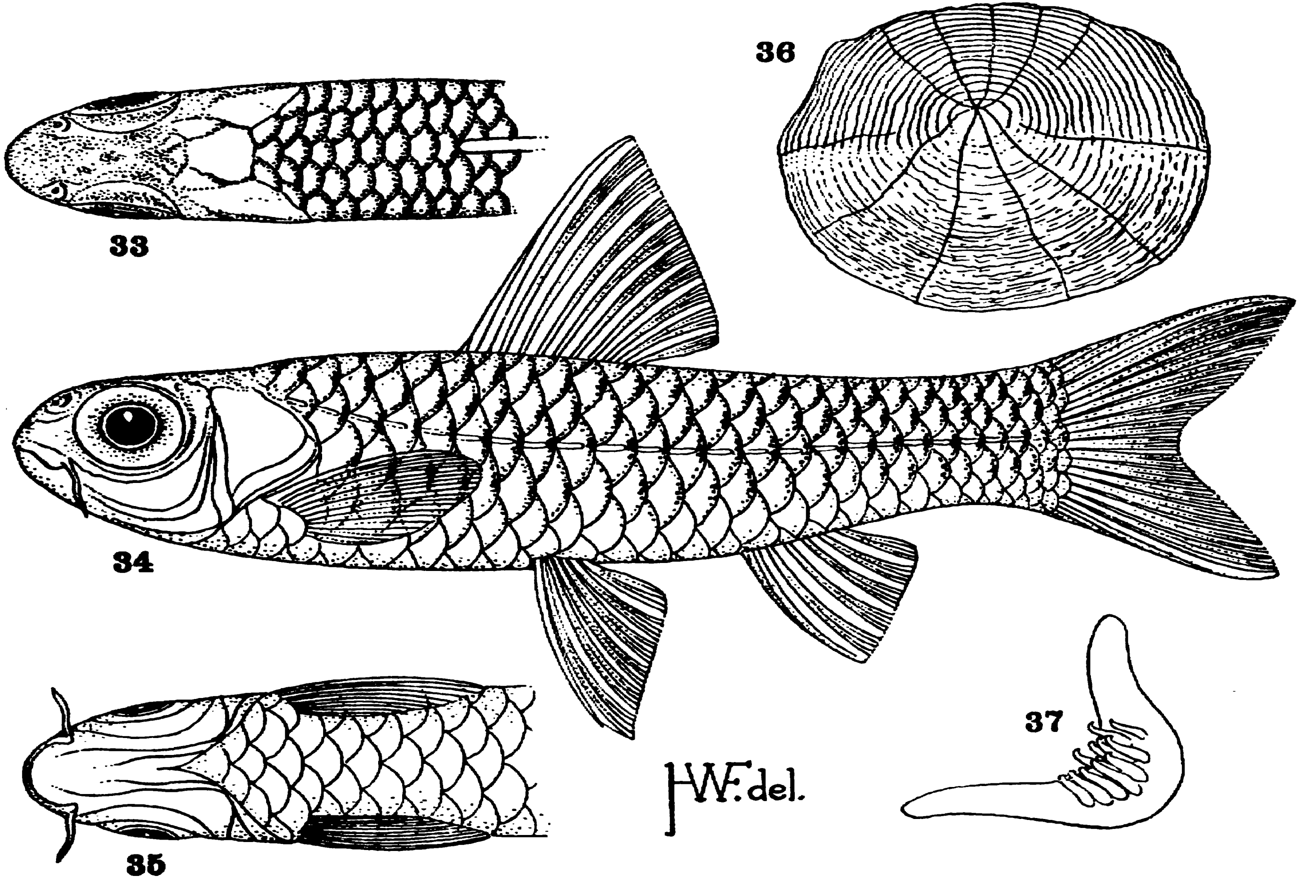
[16] Bull. Am. Mus. Nat. Hist., vol. 37, art. 25, Nov. 26, 1917, p. 700, fig. 14. Avakubi, Congo.

[17] Proc. Acad. Nat. Sci. Phila., 1936, p. 272.



Puntius syntrechalepis new species. Fig. 33.—Head above. Fig. 34.—Lateral view of type. Fig. 35.—Head below. Fig. 36.—Scale, 3 mm. Fig. 37.—Right pharyngeal .

Myers 1924 (based on *B. rubripinnis* Nichols and Griscom 1917 preoccupied) in that only $1\frac{1}{2}$ rows of scales are shown both above and below the lateral line on the caudal peduncle, also $1\frac{1}{2}$ above to dorsal origin and but a single row below to the ventral origin. *Puntius syntrechalepis* agrees with *Barbus bomokandi* in having but a single pair of barbels, but it does not have the black post-opercular bar, nor is this present in *B. kemoensis.*

(*συντρεχα* converge + *λεπις* scale; with reference to the scales on the tail.)

Barilius shariensis new species Figures 38 to 42.

Depth $5\frac{1}{4}$; head $3\frac{5}{8}$, width $2\frac{1}{4}$. Snout $3\frac{3}{4}$ in head measured from snout tip, which is level with center of eye; eye 4, lateral, elevated; mouth large, gape long, oblique; maxillary reaches below middle of eye, length $2\frac{1}{10}$ in head measured from snout tip; closed lower jaw slightly protrudes in front; suborbitals broad, entirely covering cheek; interorbital rather broadly convex, width 3 in total head length. Gill opening extends forward to opposite center of eye. Branchial arches damaged. Right pharyngeal teeth 5, 3?, 2, hooked, each of larger ones with grinding surface.

Scales 48 + 3 in lateral line; 7 above to dorsal origin, 1 below to ventral origin, 2 below to anal origin; 24 predorsal. Scales all more or less uniformly small, on fins only present on caudal base.

D. II, 7, second simple ray entire, flexible, $1\frac{3}{7}$ in total length of head; A. III, 13, first branched ray $1\frac{4}{5}$; least depth of caudal peduncle $2\frac{3}{4}$; caudal forked, lower lobe little longer than upper and contained $3\frac{4}{11}$ in rest of fish; pectoral $1\frac{1}{4}$ in total head length, rays I, 12; ventral $1\frac{9}{10}$, rays I, 6.

Color in alcohol dull brown, lighter or paler below, and each scale on back with brownish margin. Interorbital and top of snout largely dark brown; as seen from above, cranium with group of 4 large pale rounded blotches. Along side axially on trunk posteriorly and on tail, a dark gray line, posteriorly giving place to a large ellipsoid black blotch, which extends well over caudal basally and somewhat out on middle caudal rays but not to their margins. Axially and along dark gray line, row of 17 inconspicuous or obscured gray blotches, appearing as if faded out. Dorsal and caudal fins more or less pale brown, other fins whitish. Iris grayish, evidently white in life.

A.N.S.P., no. 71902. Bahr Sara, Shari River basin near Ft. Archambault. March 13. Length 68 mm. Type.

Only the type obtained. Most closely related to *Barilius kingsleyae* Boulenger, as described and figured by him.[18] It differs in a number of details, so that it is apparently worthy of distinction from the Congo and Cameroon forms. In *B. shariensis* the closed mandible is longer than the upper jaw or snout, the naked space between the third suborbital and the preopercular ridge is about half the width of the third suborbital, dorsal origin little nearer occiput than caudal base and 13 branched anal rays (Boulenger giving 14 to 17), the dark lateral spots given as 10 to 14 though

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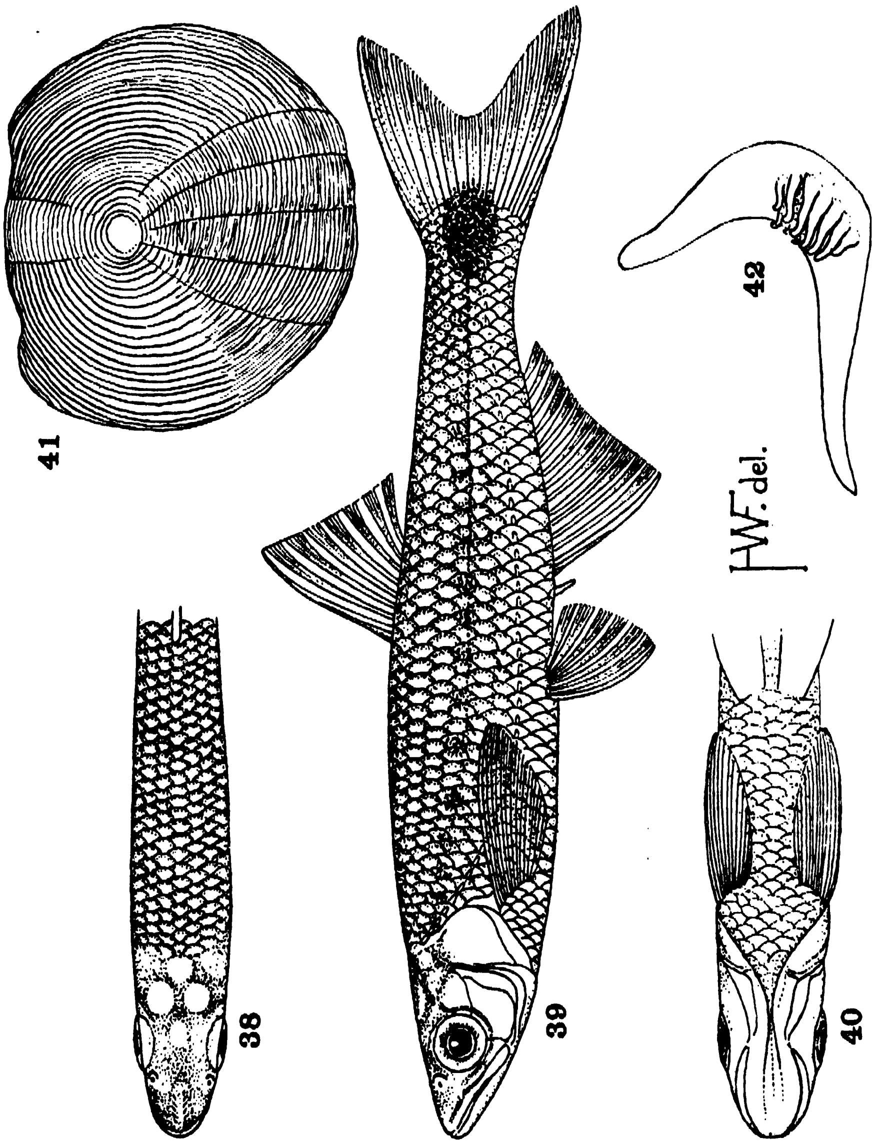
[18] Cat. Fresh water Fishes of Africa, vol. 2, 1911, p. 202, fig. 177.



Barilius shariensis new species. Fig. 38.—Head above. Fig. 39.—Lateral view of type. Fig. 40.—Head below. Fig. 41.—Scale, 2 mm. Fig. 42.—Right pharyngeal.

Guenther's figure shows 12 besides the black caudal blotch, which is not as large as the eye, nor is it extended out on the subbasal portions of the middle caudal rays. In *B. shariensis* the black caudal blotch is as long as 2 eye diameters.

(Named for the Shari River.)

CHLARIIDAE

Chlarias angolensis macronema new subspecies Figures 43 to 47.

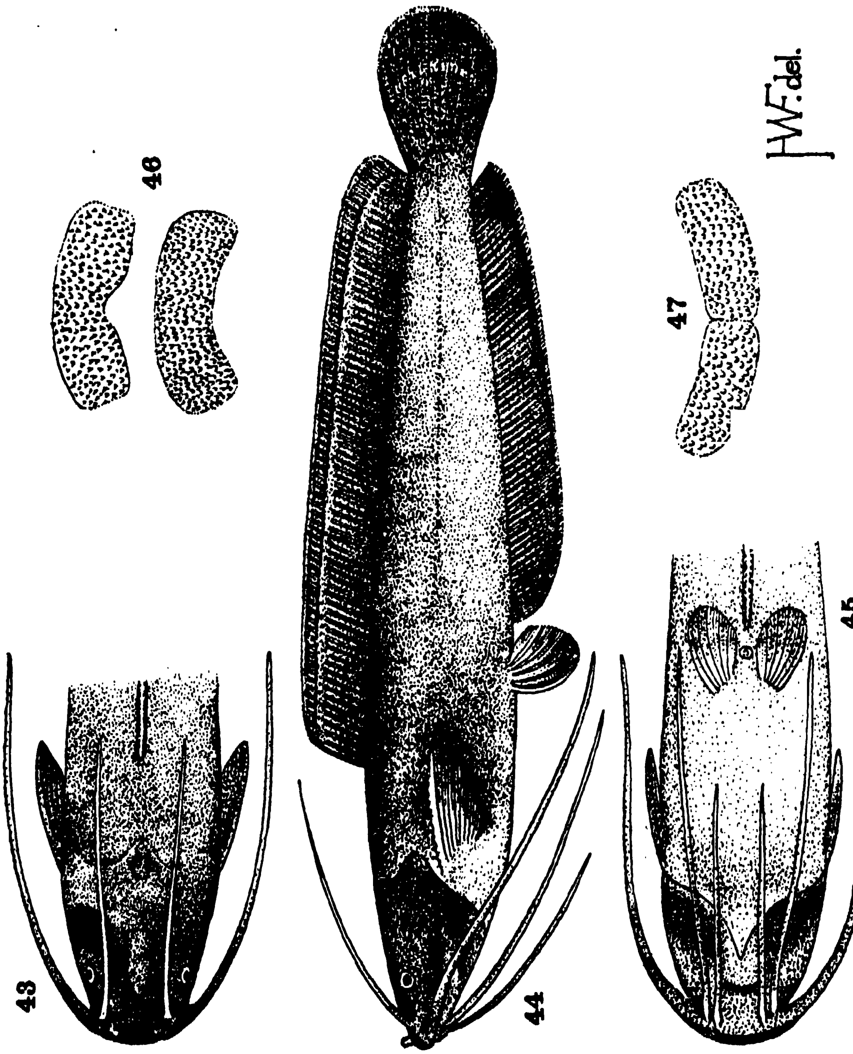
Depth 5⅞ to 6⅓; head measured to hind edge of gill opening 4 to 4⅞, width 1⅒ to 1⅛. Snout broad, length (in profile) 3 in head; eye with free lid all around, diameter 7¾ to 9 in head, 3 in snout; mouth broad, width about 2 in head; lips feebly papillate; barbels all long, nasal pair nearly or quite reaching dorsal origin, ⅞ to dorsal origin in half grown specimen; maxillary and outer mental barbels nearly or quite reach vent, in half grown, maxillary barbel reaches first third in anal and outer mental to middle of depressed ventral; inner mental barbels reach over or about ⅔ to ventral origin; upper dental areas similar, broad, parallel, with fine and slightly pointed teeth; mandibular teeth similar to upper teeth, only dental plates slightly broader; interorbital covered with thin skin and fontinels large; interorbital 2 to 2⅛ in head. Inside gill opening with tubercle on shoulder girdle. Gill rakers 2 + 12, lanceolate, subequal with gill filaments, which equal eye.

Skin smooth, without rugae on head above. Lateral line distinct, axial, complete.

D. 75 to 79, fin height 2⅛ to 2⅙ in head, fin free from caudal and predorsal length 3⅒ to 3⅛ in standard length of fish to caudal base; A. 60 to 62, fin height 3 to 4¾ in head, fin well free from caudal behind, fin origin slightly nearer snout tip than caudal base; least depth of caudal peduncle 3 to 4 in head; pectoral (spine broken off or with only short basal section remaining) shows a few basal serrae on its outer edge, fin length 1⅓ to 1⅗ in head, rays 8; depressed ventral encroaches on front of anal last fourth of fin length, fin 2¼ to 2⅓ in head, rays 6.

Color in alcohol dark blackish brown above, only paler on belly, where it is gray brown. Lower surface of head brown, though darker than belly. Iris gray black. Barbels largely gray brown for their greater part terminally, blackish brown basally and subbasally, especially the maxillary and outer mental pairs. Vertical fins and pectorals blackish brown. Dorsal with narrow pale or light gray submarginal band its whole length, and more arched posteriorly down to base of last dorsal ray than is margin of fin. Caudal with nearly median, narrow gray to whitish band, arched backward. Anal with narrow pale edge, bounded by submarginal blackish border. Pectoral dark or blackish brown. Ventral dull brown, little darker terminally.

The smaller paratype differs from the two larger specimens in having a more or less subdued variegated coloration. Thus its dorsal is largely mottled with dark to blackish gray, so that basally some of the dark markings become dark blotches, while on the back and flanks they assume irregular large blackish marblings or cloudings. The back and flanks also are marked with innumerable pale to grayish or even whitish dots, or very small spots. In addition to the very narrow pale margin of the anal fin, also a submarginal narrow white band is present its whole extent. Below and along each side of head extended back from each mandibular ramus is a pale band, bounded below by each blackish area of the branchiostegals. Besides, the belly and under abdominal surfaces are pale or more whitish than in the larger paratypes.



Chlarias angolensis macronema new subspecies. Fig. 43.—Head above. Fig. 44.—Lateral view of type. Fig. 45.—Head below. Fig. 46.—Upper dentition. Fig. 47.—Lower dentition.

A.N.S.P., no. 71903. Oka, Congo system. January 31. Length 168 mm. Type. Marked with a large though comparatively inconspicuous jet black blotch behind the right eye.

A.N.S.P., nos. 71904 and 71905. Same data. Paratypes. Length 119 to 155 mm.

Compared with the Congo specimens I reported as *Clarias angolensis*,[19] the present form shows longer barbels, slightly more dorsal and anal rays and different details in coloration. The increased number of gill rakers given by Boulenger for *C. angolensis* would appear to pertain to adult or large examples.

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[19] Proc. Acad. Nat. Sci. Phila., 1936, p. 297 (length 60—201 mm.)

(*μακρὸς* long + *νῆμα* thread; with reference to the barbels.)

Clariallabes melas lembesseensis new subspecies Figures 48 to 52.

Depth 7¾ to 8¾; head 5 to 6⅜, width $1\frac{1}{10}$ to 1⅓ in its length measured to gill opening. Snout broad, depressed, its front tip below level of eye; eye 2 to 3 in snout, 8 to 9 in head, eyelids not free but united with surrounding skin of head; mouth broad, inferiorly terminal, with upper jaw protruded in front; lips rather feebly papillate; nasal barbel reaches back as far as tip of supraoccipital extension, maxillary nearly to hind end of depressed pectoral, outer mental subequal with maxillary and inner mental about to pectoral origin; upper teeth in 2 parallel bands, those on maxillary little shorter and palatine plate arched, likewise mandibular, all with simple, conic and rather slender teeth; interorbital and top of head covered with skin, but no postocular plates. Inside gill opening cartilaginous tubercle on shoulder girdle. Gill rakers 1 + 8, lanceolate, subequal with gill filaments or eye.

Skin smooth, and without any rugae on head or shoulder girdle, all the exposed surfaces covered with thin skin. Lateral line complete, axial.

D. 98 to 109, origin of fin little nearer ventral origin than pectoral origin, fin height 2 in head, predorsal length $3\frac{8}{10}$ to 4 in standard length to caudal base; A. 90 or 91, fin height 3 in head; caudal rounded convexly behind, length 1⅛ to 1½ in head; pectoral 2 to 2⅛, short spine half length of fin, outer edge feebly roughened or with a few irregular obscure points, and inner edge with 6 large denticles, rays I, 8; ventral 2¾ in head, as depressed scarcely encroaching on anal fin, rays I, 6.

Color in alcohol dark brown generally, but with borders of vertical fins all constrasted or light brown; posteriorly they all show a narrow pale submarginal band, more or less better defined as median semicircle on caudal. Paired fins very pale or light, with dark brown shade on pectoral basally. Head below more or less dark to blackish brown. Barbels dark brown. Iris gray black.

A.N.S.P., no. 71906. Oka, Congo system. January 31. Length 165 mm. Type.

A.N.S.P., nos. 71907 to 71908. Same data. Length 82 to 134 mm. Paratypes.

Clariallabes melas Boulenger[20] differs in a more slender body with the depth 10 to 11, smaller eye, shorter barbels, more numerous gill rakers 12 to 15, longer pectoral and also longer pectoral spine and a uniform blackish brown coloration. Boulenger's type was 260 mm. and a half grown specimen is listed without comment. As my specimens approach the only known

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[20] Fresh water Fishes of Africa, vol. 2, 1911, 268, fig. 223. Lower Congo.

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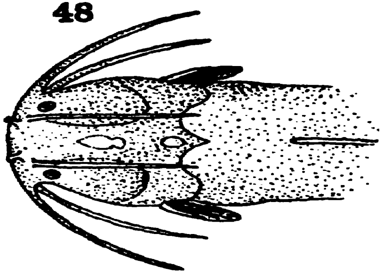

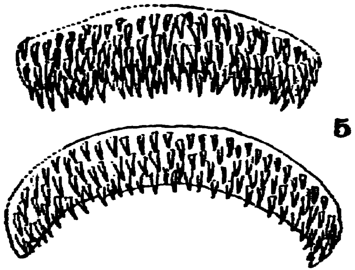

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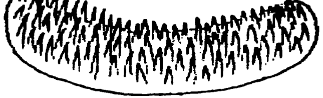

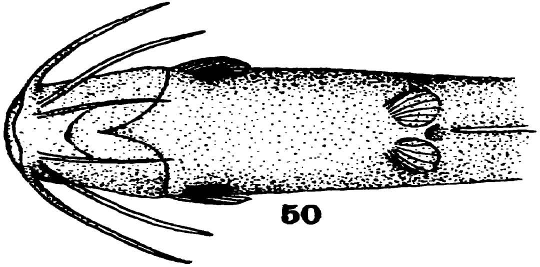

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Clariallabes melas lembesseensis new sub type. Fig. 50.—Head below. Fig. 51.—Uppe den Fig. 48.—Head above. Fig. 49.—Lateral view o plates. Fig. 52.—Lower dental plate.

species of the genus, which is described without definite locality in the vast Congo basin, and in view of the striking difference above noted, I prefer to consider them more as a special form or subspecies representative of the Lembesse basin.

(Named for the Lembesse River.)

PORCIDAE

Chrysichthys okae new species Figures 53 to 58.

Depth 3⅖; head 2⅘ to 3, width 1¼ to 1⅖. Snout 2⅓ to 3 in head, convex, its tip low or nearly level with depressed pectoral spine as depressed; eye large, diameter 2⅞ to 3½ in head, close to upper profile; maxillary not reaching eye, or about to eye in immature; mouth low, inferior, horizontal, broad, cleft short; lips rather wide; nasal barbel as long as eye, maxillary reaches to middle of depressed pectoral; outer mental reaches to, or slightly beyond pectoral origin and inner mental ½ to ⅔ length of outer; teeth in villiform bands in jaws, lower band narrower; narrow band of villiform teeth on each palatine; tongue broad, fleshy; interorbital low, width greater than eye in immature, subequal with age; dorsal plate and occipital extension complete bony bridge; top of head rather feebly rugose or with granulated surface. Gill rakers 3 + 9, lanceolate, long as gill filaments.

Skin smooth. Cranium and predorsal plate only feebly rugose, also outer surface of clavicle.

D. I, 6, spine serrated on both edges but with serrae rather inconspicuous, length 1½ in head; A. IV, 5, fin rather small, when depressed not reaching caudal base; least depth of caudal peduncle 3⅛ to 3½ in head; caudal deeply emarginate, its length 3⅖ to 3½ in rest of fish; pectoral rays I, 7 or I, 8, spine with both edges serrated and 10 or 11 larger serrae along inner edge of fin, length 1¼ to 1⅔ in head; ventral 1⅘ to 2⅒, rays I, 6.

Color in alcohol brown above, pale brown to whitish beneath, especially on belly and under surfaces. Iris dark gray, evidently pale or whitish in life. Barbels all pale brown. Black blotch below dorsal and another below adipose fin. Indistinct darker or ill-defined blotches on side of body. In young they are more defined and several on predorsal region. Fins all more or less pale or very light brown.

A.N.S.P., no. 71909. Oka, Congo system. January 24. Length 80 mm. Type.

A.N.S.P., no. 71910. Same data. Length 48 mm. Paratype.

The species appears to be allied with *C. cranchii* (Leach) as described by Boulenger.[21] It differs in many ways from both his description and figure. Thus the body and head proportions are far deeper and longer, the snout well protruded, the barbels are longer, only 5 branched anal rays present, and the coloration variegated with dark spots and several black blotches. The young of *C. cranchii* does not appear to have been described, Boulenger noting that the pectoral spine is " strongly serrated on inner side

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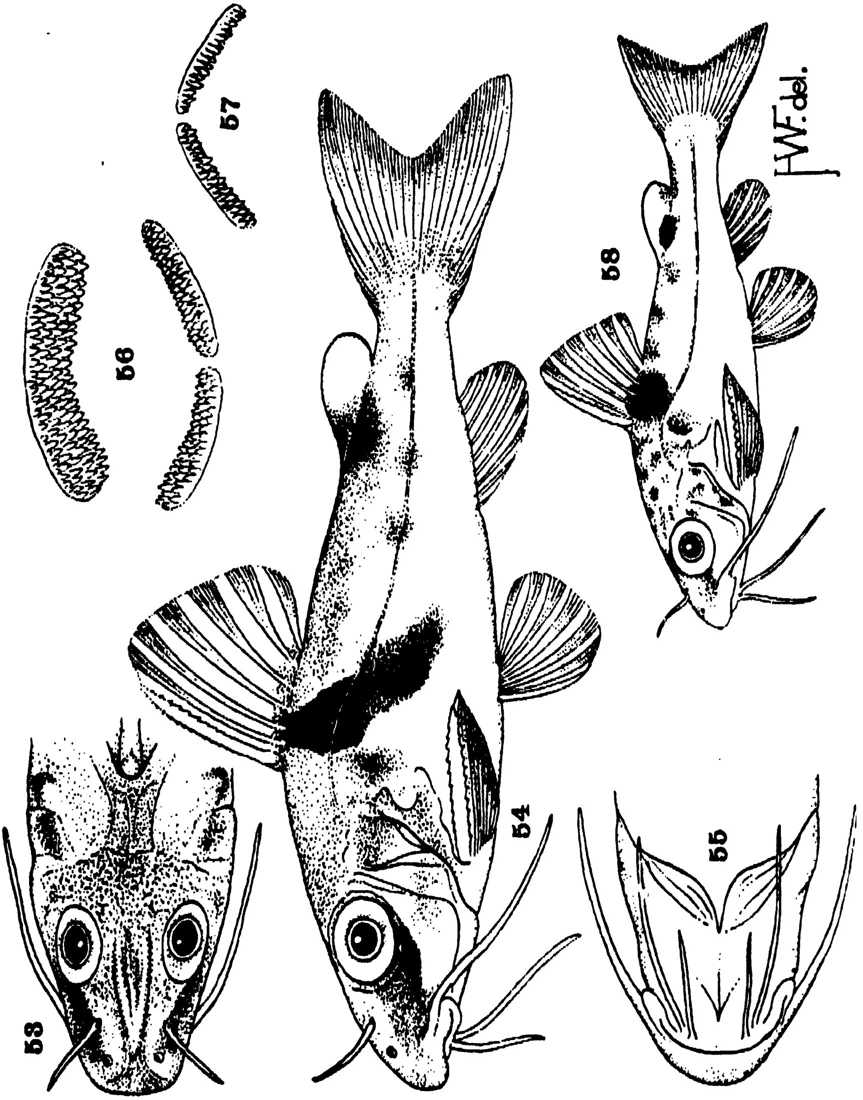
[21] Cat. Fresh water Fishes of Africa, vol. 2, 1911, p. 332, fig. 260.



Chrysichthys okae new species. Fig. 53.—Head above. Fig. 54.—Lateral view of type. Fig. 55.—Head below. Fig. 56.—Upper and lower jaw dental plates. Fig. 57.—Palatine plates. Fig. 58.—Immature.

in the young" with his figure showing but 8 serrae as seen from above. As the species reaches a large size (1000 mm.), its color is given as, "dark brown above, white beneath." Nichols and Griscom (1917) list 10 specimens from about 125 to 305 mm. in length from 4 Congo localities, but give no details.

(Named for Oka the type locality.)

Clarotes laticeps (Rueppell)

Depth 4⅛ to 5; head 3, width 1¼ to 1⅓. Snout (in profile) 3 in head; eye 5 to 5¼, 1⅞ to 2 in snout, 2 to 2⅜ in interorbital; maxillary barbel reaches to beyond depressed pectoral tip or to middle of depressed ventral; nasal barbel equals 1 + ¼ to 1 + ¾ eye diameters; outer mental barbel 1½ in head; inner mental barbel 2⅙ to 2⅓; mouth width 2 to 2⅓; rather broad bands of villiform teeth in jaws and vomerine-palatine band continuous, narrower and little longer than upper jaw band; interorbital 2¼ to 2½ in head, level. Cranium above and dorsal plate rugose, also humeral scute. Gill rakers 8 + 17, lanceolate, subequal with gill filaments.

D. I, 6, front edge with 5 apical antrorse serrae and hind edge with 8 small ones; adipose fin with 14 obscure slender rays; A. v, 6, I, fin height 1¾ to 1⅞ in head; least depth of caudal peduncle 3⅛ to 3¾; caudal deeply forked, length 3⅙ to 3¼ in rest of fish; pectoral 1¼ in head, spine 1⅞ to 1½, its outer edge antrorsely serrate, 14 longer antrorsely serrate denticles on inner edge; ventral I, 5, fin 1⅞ in head.

Color in alcohol with upper half of head and body dark brown, well contrasted from whitish under surfaces. Diffuse black blotch size of eye behind gill opening above. Iris gray. Nasal barbels brownish, all others pale or more or less whitish. Dorsal brown, spine paler. Adipose fin brown. Caudal with upper lobe brown, median rays white, also lower broad border and upper median rays brown. All other lower fins pale brownish.

Two, 198 to 213 mm. Bahr Sara, Shari River basin. March 13.

CYPRINODONTIDAE

Epiplatys stictopleuron new species Figures 59 to 63.

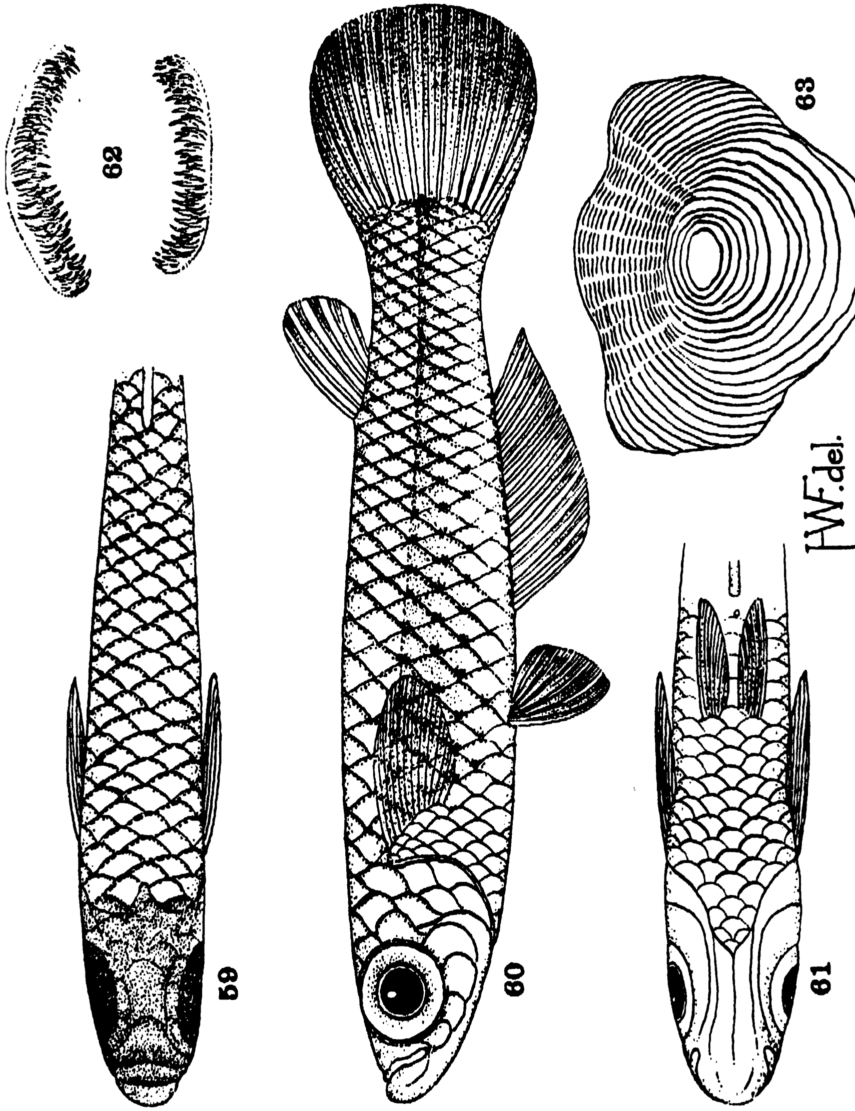
Depth 4¾ to 4⅞; head 3½ to 4⅛, width 1¾ to 2. Snout short, high, its front end slightly below level of upper edge of pupil, length (in profile) 4½ to 5⅛ in head as measured from snout tip; eye large, high, impinging on upper profile of head, diameter 2¼ to 2⅜ in head measured from snout tip; mouth broad, cleft short, inclined and as closed, mandible strongly protruded in front; premaxillaries greatly protractile; teeth 16 above and 12 below, slender, curved, conic, form band with 2 to 4 teeth transversely in each jaw, mostly smaller towards angles of jaws; interorbital 2¼ in head, broad, level. Gill opening large, cleft well forward or about opposite middle of eye.

Scales 25 + 3 in axial lateral series; 5 transversely at dorsal origin; 18 predorsal forward to head. Head largely scaly, with a single row of suborbital scales. Scales on trunk largest, becoming smaller on caudal peduncle and finally a band of scales over caudal base.

D. 6, depressed fin not reaching caudal base; A. 17, origin nearly midway between middle of eye and caudal base; caudal peduncle as long as deep; caudal rounded behind, subequal with head; pectoral inserted high, rays 12; ventral rays 7, fin about ⅝ length of pectoral.

Color in alcohol brown, dull or pale generally. A grayish axial lateral band from head, wide over side of trunk and narrowing to dark or blackish line on side of caudal peduncle. In its course, and also along those of 2 longitudinal series of scales below, each with dark to blackish basal blotch.

Iris dark gray, apparently silvery to whitish in life. Top of head dark brown. Black line along anal base. Fins all pale brown to nearly transparent, only caudal with broad outer portion darkened with grayish.



Epiplatys stictopleuron new species. Fig. 59.—Head above. Fig. 60.—Lateral view of type. Fig. 61.—Head below. Fig. 62.—Dentition. Fig. 63.—Scale, 2 mm.

A.N.S.P., no. 71911. Oka, Congo basin. January 24. Length 27 mm. Type.

A.N.S.P., nos. 71912 to 71919. Same data. Length 20 to 26 mm. Paratypes.

Among the various species of this genus included by Boulenger as *Haplochilus*, this one does not appear to be allied with any. In his key it would enter section B. and 1, having reduced dorsal rays but also with one more anal ray than he gives, though with equally large scales and rounded caudal fin. Of these species only *E. macrostigma* (Boulenger), *E. nigricans* (Boulenger), *E. multifasciatus* (Boulenger) and *E. singa* (Boulenger) are from the Congo basin. All are greatly dissimilar to the present species.

(στικτὸς spotted + πλευρὸν side.)

Epiplatys ndelensis new species Figures 64 to 68.

Depth 4¼ to 5⅛; head 2⅞ to 3, width 1¼ to 1½. Snout broad, depressed, length (in profile) 4 to 4¼ in head measured from snout tip, which is about level with middle of eye; eye 2¾ to 3, slightly impinging on upper profile of head, exceeds snout, 1⅝ to 2 in interorbital; mouth broad, cleft short and closed mandible little protruded in front; maxillary small, little inclined, reaches to opposite front edge of eye; teeth in narrow bands in jaws, with upper band much less extensive than wider lower one, the outer series of teeth comprising 36 small curved ones, mostly pointed though some with blunt ends and a little larger in middle of jaw; interorbital broad, nearly level, width 1¾ in head. Gill opening extends forward opposite middle of eye.

Scales 26 or 27 + 2 in axial lateral series; 7 transversely above anal origin; 19 predorsal scales to middle of interorbital. Head largely scaly, muzzle naked. Narrow band of scales on caudal base.

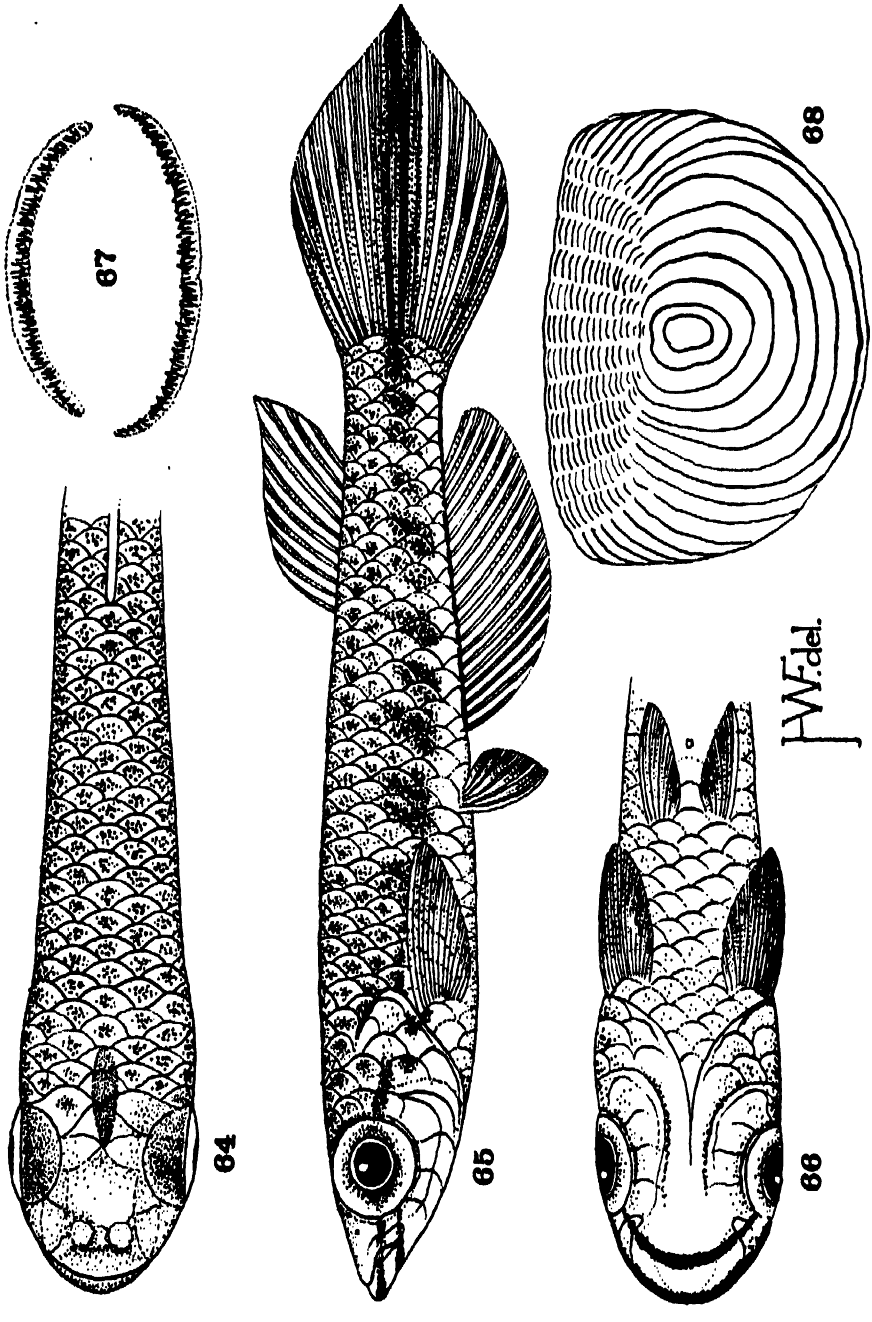
D. 10, fin highest posteriorly and fin height 1⅝ to 2 in total head length; A. 18, fin base 1 to 1⅛ in total head length; least depth of caudal peduncle 2¼ to 3; caudal cuneate, median rays longest, fin 2½ to 2⅔ in rest of fish; pectoral base placed below level of eye, fin length 1⅝ in total length of head, rays 12; ventral rays 6, fin 3 in total length of head.

Color in alcohol rather light brown, mostly each scale on back with brown spot and under surfaces uniform. Beginning on front edge of mandible narrow dark or blackish brown band which extends through eye and irregularly along postocular region broken mostly as several blackish blotches. Along side below median line or axis, a dark brown band extending from above pectoral, this seen to be composed of 10 blackish blotches, little inclined and none extending above median line. At caudal base dark blotch which continues out posteriorly and narrowly over median rays of caudal. On mandible below another dark band crosses the chin to the lower front edge of the eye. Dark line along each side of base of anal fin and behind it continued as median line to caudal fin. Fins appear largely uniform brownish. Iris gray to dark gray.

A.N.S.P., no. 71920. Ubangui-Shari near N'délé. March 2. Length 25 mm. Type.

A.N.S.P., nos. 71921 to 71923. Same data. Length 19 to 23 mm. Paratypes.

A species distinguished principally by its coloration, especially in the presence of 2 dark brown cross bands over the chin, each beginning at the



Epiplatys ndelensis new species. Fig. 64.—Head from above. Fig. 65.—Lateral view of type. Fig. 66.—Head from below. Fig. 67.—Dentition. Fig. 68.—Scale, 2 mm.

front of the eye. Similar bands are shown in the figure given by Boulenger for his Congo *Haplochilus multifasciatus*.[22] These are described simply as " two black bars across the chin " and the figure does not indicate them as reaching the eye, though the upper one is not marginal on the mandible. Moreover other details with dark cross bars on the body and spots on the fins are quite different. *H. multifasciatus* is said to have 14 or 15 anal rays and 8 or 9 dorsal, and the figure shows the anal fin base 1½ in the total head length.

(Named for N'délé the type locality.)

LEMBESSEIA new genus

Type.—*Lembesseia parvianalis* new species.

Body elongately ovoid in contour, with long and rather deep caudal peduncle. Head moderate, depressed and flattened above. Snout broad, depressed as seen from above, its front upper profile nearly straight. Eye high, touches upper profile of head, large. Mouth wide, cleft rather short. Premaxillaries greatly protractile. Teeth minute, simple, crowded rather irregularly in narrow bands in jaws. Interorbital flat. Gill rakers lanceolate. Scales large, exposures narrowly imbricate. Of fins, only caudal base scaly. Dorsal little postmedian in standard length, small, ornate. Anal begins below middle of dorsal, small. Caudal rounded. Paired fins small, with ventrals pointed.

A genus distinct in combination of characters and details as set forth in its description above. Among Boulenger's African genera it approaches the species he includes in *Fundulus*. Curiously its facies suggests none of them, but superficially recalls some American poeciliid genera. It surely differs from the African forms in this physiognomy, fin position and the prominent caudal peduncle. In the same manner it may be said to differ from *Epiplatys*.

(Named for the Lembesse River basin.)

Lembesseia parvianalis new species Figures 69 to 74.

Depth 3; head 3¼, width 1½. Snout short, broad, depressed, much shorter than eye, length from its tip 4½ in head and tip level with upper part of pupil; mouth with short lateral cleft, wide, and closed mandible slightly longer in front; lips thin, narrow; maxillary short, reaching but little over a third to eye; premaxillaries very protractile; teeth simple, conic, rather short, forming a band in each jaw of 2 to 4 irregular series; interorbital broad, low, nearly level, width in front nearly 1¾ in eye. Gill opening extends forward to opposite hind eye edge. Gill rakers 22, slender, lanceolate, subequal with gill filaments.

Scales 27 + 6 in axial lateral series; 9 transversely between dorsal and ventral fin origins; 13 predorsal forward to occiput; suborbitals with single row of scales forward and 3 across cheek to its angle below. Scales on caudal base rather small. Scales with 13 or 14 basal radiating striae.

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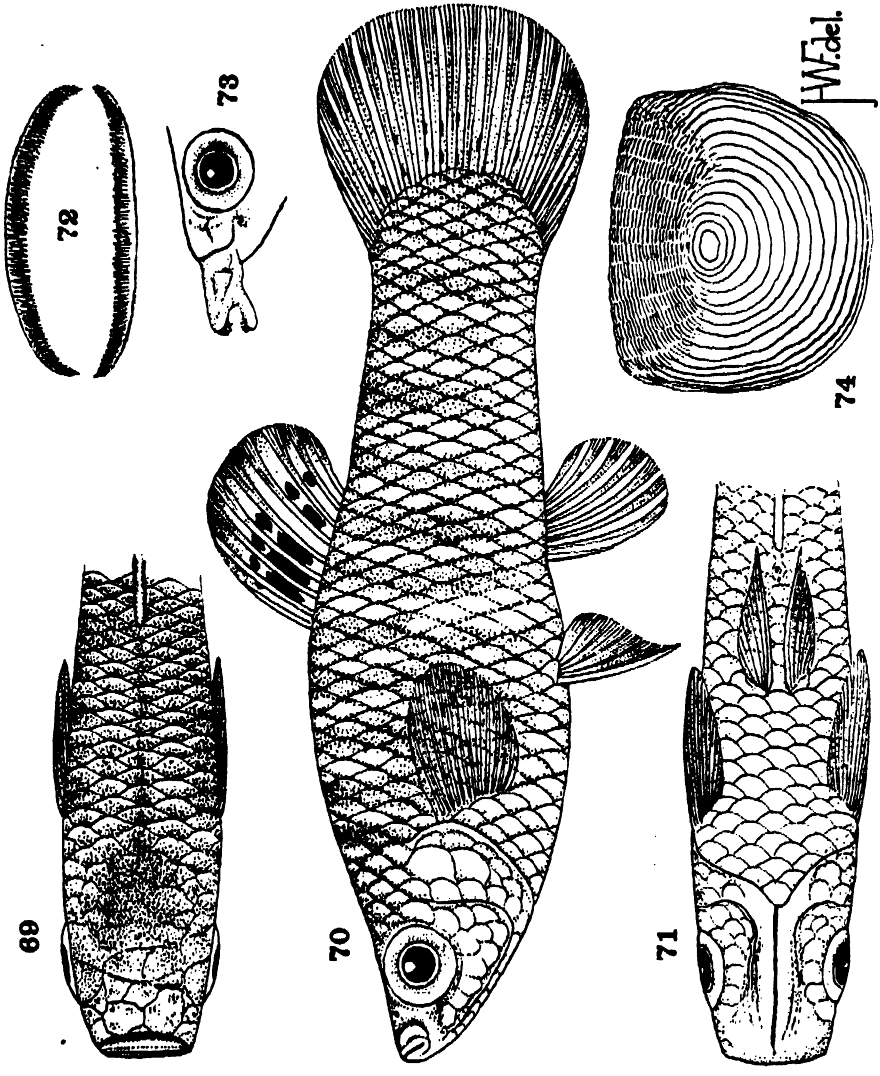
[22] Cat. Fresh water Fishes of Africa, vol. 3, 1915, p. 75, fig. 75.



Lembesseia parvianalis new species. Fig. 69.—Head above. Fig. 70.—Lateral view of type. Fig. 71.—Head below. Fig. 72.—Dentition. Fig. 73.—Protracted jaws. Fig. 74.—Lateral scale, 3 mm.

D. ɪɪ, 7, edge rounded, fin height 1⅜ in total head length; A. ɪ, 7, small, origin below middle of dorsal base, fin height 1¾ in total head length; least depth of caudal peduncle 1⅜, 1¼ in its length measured from base of last anal ray; caudal rounded convexly behind, length 3⅛ in rest of fish; pectoral rays 13, fin 1⅜ in total head length; ventral rays ɪ, 5, fin pointed, length 1⅞ in total head length.

Color in alcohol dull brown generally above and on sides of body, each of scales with narrow darker edges. Squamous area on caudal base more or less with pale yellowish brown tinge. Iris grayish. About 10 obscure slightly darker gray ill-defined vertical bars on sides of body. Under surfaces of head, chest and abdomen pale to whitish. Dorsal pale grayish, with median row of several black spots on membranes and a subbasal larger black blotch on the second, third, fourth and sixth membranes. Outer marginal portion of dorsal more or less gray. Caudal grayish marginally and membranes medially marked with a few inconspicuous darker gray spots. Other fins all pale.

A.N.S.P., no. 71924. Oka, Congo system. January 24. Length 39 mm. Type.

Only the type secured. Its specific distinctions are included in the above generic account.

(*parvus* small + *analis* with reference to the anal fin.)

ANABANTIDAE

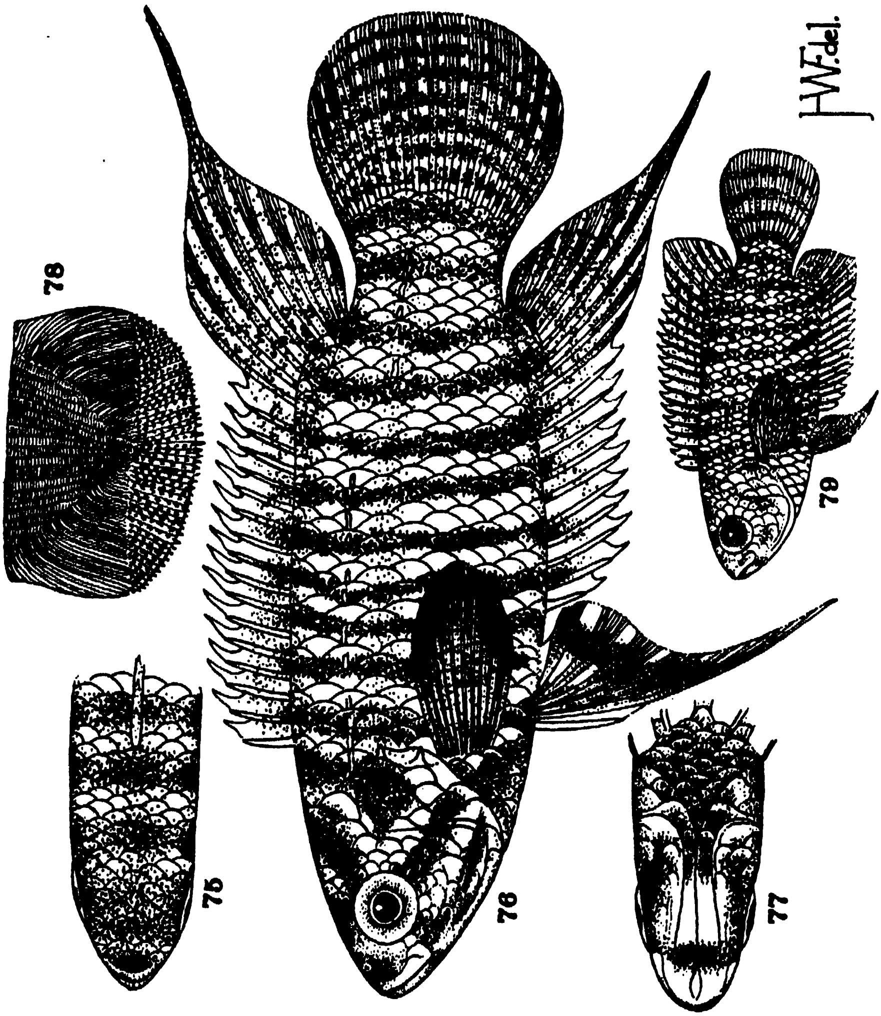
Ctenopoma congicum longipinnis new subspecies Figures 75 to 79.

Depth 2¾ to 2⅞; head 2⅔ to 3, width 1⅞ to 2⅛. Snout broad, conic, length 5 to 5⅛ in head measured from snout tip, which is level with the center of eye; eye 3⅒ to 3⅛, advanced, greater than snout; maxillary reaches to opposite front edge of eye or slightly beyond; mouth supero-terminal, closed mandible but slightly protruded in front; teeth uniformly minute, simple, in bands in jaws; interorbital broadly convex, width 2¾ to 3 in head measured from snout tip; preorbital, interopercle and preopercle edges entire; subopercle edge with 4 or 5 spines above, lowest largest but still lower another large spine. Gill opening extends forward to about opposite hind eye edge.

Scales 26 + 4 in median axial count; lateral line imperfect, scales variable and often one to several tubes missing at intervals; tubes all simple on scale exposures; transversely 2 or 3 scales above upper section and below same; predorsal scales 12 or 13; head largely scaly, with small scales on infraorbitals and large ones on opercles. Rather large scales on chest and breast. Band of small scales along bases of soft dorsal and anal and band on caudal base.

D. XV or XVI, 7 or 8, first spine shortest, all gradually larger to last which is 2⅒ to 3 in total head length, soft fin in type with fourth ray extended and as depressed reaches well beyond caudal; A. X to XII, 10 or 11, first spine shortest and others graduated longer to last which is 2⅛ to 2½ in total head length, and in type as extended back reaches to, or a little beyond, hind edge of caudal fin; caudal with hind edge convex, length 3 to 3⅛ in rest of fish; least depth of caudal peduncle 1⅜ to 2⅛ in total head length; pectoral 1¼ to 1½, rays 12; ventral rays I, 5, fin with first ray elongated in type or reaching first anal ray base.

Color in alcohol brown, but little paler below. On body 10 transverse blackish bands, reflected on dorsals and anals basally. Several obscure dark bands radiate from eye, lower anterior crossing mandible. Iris dark gray. Fins grayish, with obscure darker blotches, as imperfect reticulations on soft dorsal and anal more or less defining paler blotches. Caudal with 8 transverse dark bands; basal darkest and more contrasted; in young



Ctenopoma congicum longipinnis new subspecies. Fig. 75.—Head above. Fig. 76.—Lateral view of type. Fig. 77.—Head below. Fig. 78.—Scale, 3 mm. Fig. 79. Para-

only 5 bands evident, but basal likewise darkest. Pectoral dark gray, blackish band on front part of fin.

A.N.S.P., no. 71925. Eight miles south of Oka, Congo system. January 31. Length 64 mm. Type.

A.N.S.P., nos. 71926 to 71936. Same data. Length 35 to 68 mm. Paratypes.

Compared with the figure of *Anabas congicus* published by Boulenger (*Ctenopoma congicum congicum*), all my specimens of *C. congicum longipinnis* differ in showing but 4 large scales along the lower edge of the gill opening (6 counted on Boulenger's figure). He also notes the dorsal with

" longest soft rays $\frac{3}{4}$ to $\frac{4}{5}$ length of head in females and young, produced and longer than head in males." The coloration is given as, " yellowish to dark brown, spotted with blackish, with light spots on the lower half of the body and on the vertical fins, the dark and light spots sometimes forming wavy vertical bars," the type 85 mm. in total length. His figure of the type, however, shows no dark or vertical bars on the body or fins, the dark spots on the spinous dorsal and anal simulating several black longitudinal bands and the soft portions of the fins have smaller and more numerous black spots.

(*longipinnis* long fin.)

CICHLIDAE

Tilapia tholloni (Sauvage)

Depth $2\frac{1}{2}$ to $2\frac{4}{7}$; head 3 to $3\frac{1}{10}$. Snout $2\frac{3}{7}$ to $2\frac{3}{5}$ in head; eye $3\frac{1}{2}$, $1\frac{1}{4}$ to $1\frac{1}{2}$ in snout, $1\frac{1}{5}$ to $1\frac{1}{4}$ in interorbital; maxillary reaches front eye edge, length $2\frac{4}{7}$ to $2\frac{4}{5}$ in head; mouth terminal, closed jaws even in front; an outer series of bicuspid teeth in each jaw and well set inside a series of smaller uniform teeth; interorbital width $2\frac{3}{4}$ to 3? in head, broadly convex. Gill rakers 1 + 8, though uppermost on ceratobranchial bifid.

Tubular scales in lateral line 17 to 19 in upper section, 9 + 2 in lower section; 3 scales above to spinous dorsal origin, 9 below to spinous anal origin; 12 predorsal forward to front of eyes; 3 or 4 rows on cheek. Small scales on chest and breast. Caudal scaly over $\frac{4}{5}$ its extent from base.

D. XV or XVI, 9, I, fourth ray nearly reaches middle of caudal as depressed; A. III, 8, third ray reaches $\frac{2}{5}$ in caudal as depressed; least depth of caudal peduncle $2\frac{1}{5}$ to $2\frac{1}{3}$ in head; caudal $3\frac{1}{3}$ to $3\frac{3}{5}$ in rest of fish, rounded convexly behind; pectoral equals head, rays 12 or 13; ventral I, 5, fin equals head or little longer.

Color in alcohol brown. Along side axially 4 to 6 large, dark to blackish ill-defined blotches, last at caudal base medially. Black blotch on opercle. Iris dark grayish. Chin, throat and breast blackish. Dorsals grayish, with several more or less inclined upward blackish bands, which on last half of dorsal incline downward. Black blotch at base of first membrane of soft dorsal. Caudal marked with reticulating dark lines, more or less inclosing distinct spots, and hind margin of fin broadly pale. Anal grayish, with some obscure dark gray blotches, hind part of fin paler. Pectoral pale basally, with transverse dark basal bar. Ventral with front border of fin blackish, hind part grayish.

Two, 140 to 155 mm. South of Oka, Congo system. January 31.

These agree with Boulenger's figure of the type.[28] His description says ventral not reaching anal, but in my larger specimen the right ventral reaches the base of the second anal ray.

Tilapia borkuana Pellegrin — Figures 80 to 87.

Fifty-two, 36 to 127 mm. Small lake at Oasis of Fada, Territory of Chad. April 5. This interesting series shows a large variation in color

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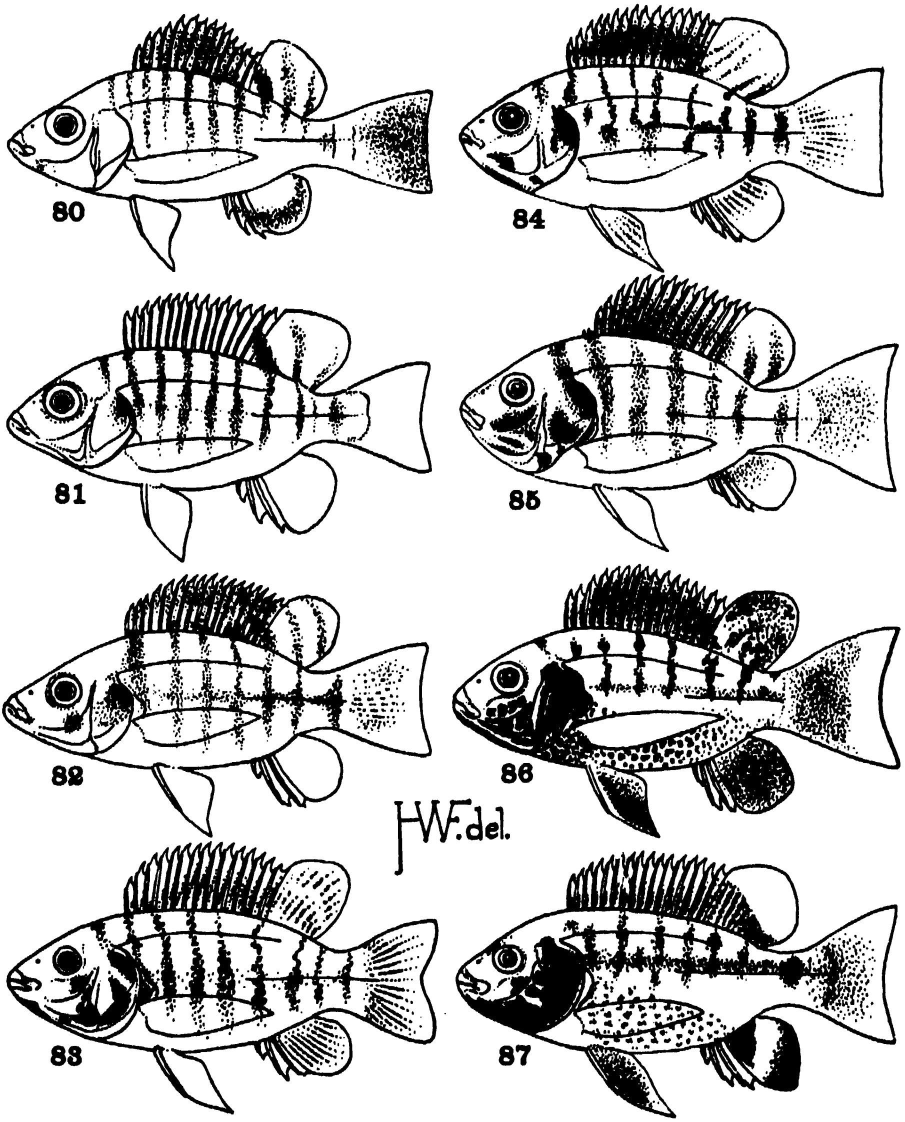
[28] Cat. Fresh water Fishes of Africa, vol. 3. 1915. p. 202. fig. 129.



Tilapia borkuana Pellegrin. Figures of variation: Fig. 80.—35 mm. Fig. 81.—49 mm. Fig. 82.—74 mm. Fig. 83.—95 mm. Fig. 84.—80 mm. Fig. 85.—96 mm. Fig. 86.—100 mm. Fig. 87.—98 mm.

markings. They agree with Pellegrin's description, especially the black markings on the head.[24]

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[24] Bull. Soc. Zool. France. vol. 44, 1919. p. 150. Ounianga, Serir, Borkou, French Equatorial Africa.

Tilapia shariensis new species Figures 88 to 93.

Depth $2\frac{5}{6}$; head $3\frac{1}{4}$, width 2. Snout (in profile) $3\frac{2}{5}$ in head, its front tip little below level of eye; eye $3\frac{3}{5}$ in head, close to upper profile, subequal with snout; maxillary reaches to opposite front edge of eye; mouth oblique, cleft moderate, closed jaws even; teeth above bifid in outer row, about 30, inner row smaller and apparently similar; lower teeth like upper, about 26 in outer row; interorbital level, width $2\frac{1}{2}$ in head. Gill opening extends forward to opposite middle of eye. Gill rakers 5 + 8, short points.

Scales 18 + 11 in lateral lines to caudal base; 1 or 2 above, 10 below; 8 predorsal extending into interorbital space. Scales on chest and breast small, largest medially on breast before ventrals. Caudal with moderate scales forming basal band comprising 2 rows, and rest of fin, exclusive only of moderately wide hind border, densely covered with small scales.

D. XV, 11, soft fin height $1\frac{2}{5}$ in head; A. III, 8, soft fin height $1\frac{3}{7}$; least depth of caudal peduncle 2; caudal convexly rounded behind, length $1\frac{1}{4}$; pectoral 1, rays I, 12; ventral I, 5, fin slightly longer than head.

Color in alcohol brown, little paler below on head and abdomen. At scale intersections scale rows show obscure, longitudinal, darker bands. Five large dark blotches along side medially and with narrow dark bar between third and fourth. Black blotch on opercle. Under surface of head and branchiostegal membranes blackish. Iris gray brown. Vertical fins brownish. Spinous dorsal with several dark gray diffuse blotches on each membrane. Soft dorsal with subbasal black blotch beginning behind last dorsal spine and extending over first and second soft dorsal membranes; posteriorly 3 black blotches basally, continued up to join horizontal gray bars so that still above a second and third dark gray band, which are more or less intersected to form reticulations. Anals grayish, with 3 or 4 parallel longitudinal dark gray bands. Caudal brown, with 5 rows of dark rings or reticulations. Pectoral dull brown. Ventral dark gray all along front border and fin dusted with gray medially, rest of fin posteriorly pale brown.

A.N.S.P., no. 71937. Bahr Sara, Shari River near Ft. Archambault. March 13. Length 97 mm. Type.

I am unable to identify this fish with any of the numerous species of *Tilapia* described and figured by Boulenger. Its color pattern is suggestive of the southern *T. sparrmani* A. Smith, though it differs in many ways from Boulenger's figure of the type, especially as that shows a scaleless caudal, and different arrangement of markings on the vertical fins. *Paratilapia corbali* Boulenger, described from Portuguese Guinea, is superficially similar in general appearance, but differs in numerous details. Boulenger's figure of the type would show the predorsal scales extending forward only about over the middle of the eye, the caudal fin not over half scaly, much greater body depth, smaller prepectoral scales, more scales on cheek and described with, " small light spots on the dorsal and caudal " though at least 3 of the dark bands on the soft dorsal reach the base of the fin.[25] .

(Named for the Shari River.)

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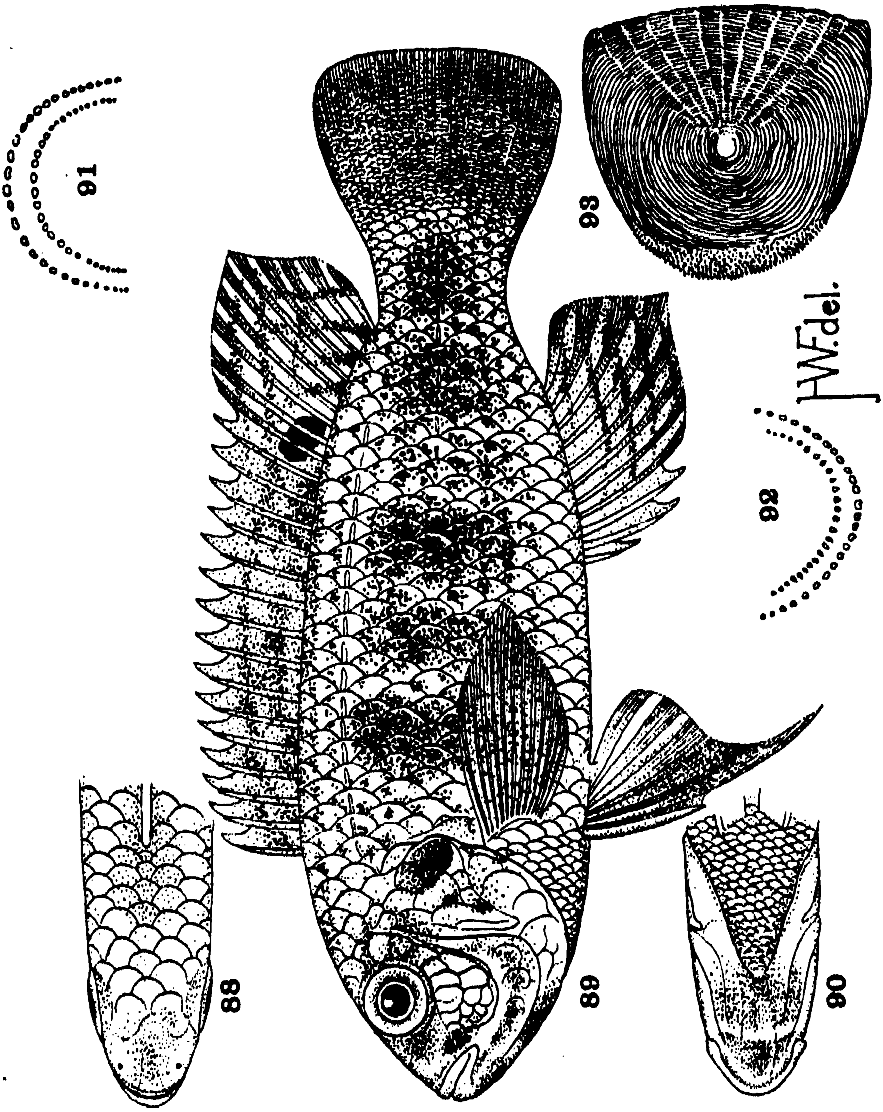
[25] Cat. Fresh water Fishes of Africa, vol. 3, 1915, p. 351, fig. 237.



Tilapia shariensis new species. Fig. 88.—Head above. Fig. 89.—Lateral view of type. Fig. 90.—Head below. Fig. 91.—Upper dentition. Fig. 92.—Lower dentition. Fig. 93.—Scale, 5 mm.

Hemichromis fasciatus Peters

Forty, 33 to 120 mm. Bahr Sara, Shari River basin. All with the characteristic black blotches, 5 in number on the sides with the last at the caudal base, besides a black opercular blotch. Compared with the figure given by Boulenger the caudal fin of my specimens is usually far more extensively covered with small scales.

Hemichromis bimaculatus Gill

Eighteen, 46 to 110 mm. Bahr Sara, Shari River basin. March 13. Caudal fin extensively covered with small scales. In the largest the soft anal is prolonged to reach back opposite the middle of the caudal fin. Characteristic are the 4 or 5 horizontal rows of small black spots below the level of the eye. The dark caudal bar is not always very prominent.

TETRODONTIDAE

Tetrodon fahaka Linnaeus

One, 290 mm. Aouk River, about 120 miles east of Ft. Archambault. " I saw natives evidently with this species of fish on the Shari River, about 18 inches in length " (Green).

Depth (contracted) 3⅖; head 3, width 1¼ in its length. Snout 2¾ in head; eye 6, 2⅘ in snout, 2⅘ in interorbital. D. III, 9; A. III, 7; P. III, 17. About 7 longitudinal parallel black lateral bands, little inclined upward posteriorly and lowest indistinct. Caudal brown, other fins light buff brown like under surfaces of body. Iris gray.

A PROPOSED BIOLOGICAL MEASURE OF STREAM CONDITIONS, BASED ON A SURVEY OF THE CONESTOGA BASIN, LANCASTER COUNTY, PENNSYLVANIA *

BY RUTH PATRICK

Curator of Limnology, The Academy of Natural Sciences of Philadelphia

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* *Acknowledgments.*—The success of this study is due in large measure to the enthusiastic cooperation and hard work of many individuals. The author of this report takes this opportunity to express her sincere gratitude to all those who took part in this program. In addition to the personnel and consultants shown on the following pages, she is also indebted to Dr. Norris W. Vaux, Secretary of Health and chairman of the Sanitary Water Board, Mr. H. G. Knox, Technical Advisor, Sanitary Water Board, Mr. J. R. Hoffert, Chief Engineer, Department of Health, Mr. Edward Edgerley, District Engineer, Department of Health, and Mr. W. B. Hart, Superintendent of Services, Atlantic Refining Co., for the many courtesies and much help during the progress of this work.

In the spring of 1948 the Sanitary Water Board of the Commonwealth of Pennsylvania asked the Academy of Natural Sciences of Philadelphia to conduct a biological survey of the streams of the Conestoga Basin. The purpose of this survey was to see if the organisms living in a stream could serve as indicators of stream conditions particularly as related to sanitary and industrial wastes.

For this purpose the Connestoga Basin was chosen. It is particularly well suited for such a project because it consists of small as well as intermediate size streams. Therefore in most cases the stream could be waded and the bottom conditions carefully studied. As the shallow water forms are the most important food sources in the biodynamic cycle of a stream whether it is large or small, it was believed that streams of this type would be the best ones on which to first conduct our studies. The conclusions reached from these studies will be further tested on large rivers. This stream basin also afforded conditions representing different degrees of pollution, industrial and sanitary wastes entering into the streams of the system at various points. On the other hand, certain streams, except for farmhouse wastes, were free of sanitary and industrial pollution.

The Conestoga Basin which has an area of 474.8 square miles is located in Lancaster County Pennsylvania. Its bedrock is composed of limestone and shale. The gradients of the streams near their headwaters are relatively steep, but soon flatten out. There are occasionally sudden drops. The topography of the land is rolling. Lancaster County is intensively farmed so that the stream margins are largely bordered by pastures and cultivated fields. Due to erosion of the clay soils, the larger streams of the system are usually turbid, and the waters are of a eutrophic type.

In planning this biological survey our major consideration was the biodynamic cycle of the stream, which normally results in a balance of plant and animal life. Brinley (1943) has recognized that the organisms in a stream divide themselves roughly into two groups; those which by their action improve the physical conditions of the water, such as the bacteria and the algae, and those which maintain a balance of life in a stream by preying and by producing general ecological competition. This biodynamic cycle is the interdependence of the various groups of organisms upon each other. For example, detritus which contains proteins, cellulose, and various sulphur compounds, enters a stream. The bacteria act upon the proteins and break them down to simple compounds such as nitrates and ammonium. They also oxidize the sulphur compounds to sulphates, all of which are utilized by green plants. Bacteria are also directly a source of food for some groups such as the protozoa.

The fungi and bacteria break down the cellulose compounds to simpler carbohydrates, which are utilized by various heterotrophic organisms.

The algae by photosynthesis build up carbohydrates and they set free oxygen which in turn is utilized by all organisms in respiration. They are also a source of food for many animals. The various groups of animals keep the fungi, bacteria, algae and each other in check, the larger ones feeding on the smaller ones. Some of the animals act as scavengers and clean up the debris. Thus all are necessary in maintaining a balance of life and energy relationships in a stream.

The effects of sanitary and industrial pollution are to alter this cycle. If the pollution is not excessive, organisms of this biodynamic cycle can assimilate it. That is, though at the point of entrance of the pollution the biodynamic cycle may be upset, further downstream the normal cycle is restored. This is referred to as the recovery or rejuvenation of a stream. Therefore the amount of an effluent entering a stream should only temporarily, if at all, upset the cycle.

Several different methods of approach have been used to ascertain whether or not an effluent is harmful to a stream. The most common methods are to determine, for industrial effluents, the Biochemical Oxygen Demand (B. O. D.), and for sanitary wastes, the B. O. D. and coliform count. These tests are valuable in measuring the oxygen consumption of an effluent and in detecting the presence of sanitary wastes. However, they may tell us very little as to the actual effect of an effluent on the life in a stream. The B. O. D. measures the oxygen consuming capacity of an effluent, but if it is determined before the effluent enters a stream it may tell us very little about the effect of the oxygen consuming capacity of that effluent after it enters a stream. This is because the physical, chemical, and environmental characteristics in a stream are so variable that they can not be reduced to a constant. Moreover such tests tell us nothing as to the toxic effect that an effluent may have on plant and animal life.

Chemical and physical analyses are also used to ascertain stream conditions. Such analyses include tests for hardness, alkalinity, pH, calcium, magnesium, sodium, potassium, ammonium, nitrites, nitrates, silicates, iron, sulphates, phosphates, chlorides, dissolved oxygen, free carbon dioxide, turbidity, suspended solids, and records of temperature and total conductivity. Such tests are of value in giving us the general characteristics of a stream, but they do not indicate whether or not the plant and animal life is balanced. There are several reasons for this. First the chemical analysis only tells us the conditions at the time the analysis was made. For instance Station 108 on Lititz Spring Run (see map 1) was the most polluted station we studied. Practically all the plant and animal life had been killed. However, in the chemical analysis of the water, which was made in July when the industries had a vacation period, and likewise in the analysis made in the fall, the only indication of pollution was a fairly high CO_2

content (6.6 p.p.m.–July; 15 p.p.m.–October). This content could hardly be considered indicative of pollution since the station is within a mile of the source which is a large limestone spring. The analysis made in August did show pollution as the nitrates were high, 4.39 p.p.m., but they did not indicate the very toxic condition which existed. To have ascertained this polluted condition by chemical means, unless the toxic substance in the effluent could have been found out by other methods, would have meant considerable testing and perhaps over an extended period of time.

Another reason why chemical tests, such as those usually performed, do not always indicate the conditions of the biodynamic cycle in a stream, is that we do not know the limits of the ranges of concentrations of various chemicals which organisms that are part of a normal biodynamic cycle can tolerate. Ellis (1937) and others have indicated for some of these chemicals, concentrations which were found to be indicative of conditions undesirable for fish life. As to dissolved oxygen, Ellis states: " 5 p.p.m. of dissolved oxygen seems to be the lowest value which may reasonably be expected to maintain in good condition varied fish faunae of warm-water fishes in our inland streams if the water temperature be 20°C. or above ". The tentative standards of the State of West Virginia classify streams as follows:

Grade B—which would be a stream with some pollution.

Dissolved oxygen: monthly average over 4 p.p.m., daily minimum 3 p.p.m.

B. O. D.—monthly average, not over 6 p.p.m., daily maximum not over 7 p.p.m.

Grade A—which is an unpolluted stream.

Dissolved oxygen: monthly average over 6 p.p.m., daily minimum 5 p.p.m.

B. O. D.: monthly average not over 2.5 p.p.m., daily maximum 3.5 p.p.m.

As to pH, Ellis (1937) states that a pH from 6.5-8.5 is to be expected in most fresh-water streams. The specific conductivity of streams supporting a well-developed fish fauna was between (Ellis 1937) 150-500 mho × 10^{-6} at 25°C. According to an inspection of the literature, nitrates in a healthy stream in the eastern United States should not be over 2 p.p.m. As to free carbon dioxide, amounts in excess of 3 cu. centimeters per liter (6 p.p.m.) are indicative of pollution in flowing inland streams (Ellis 1937).

The stations which we studied were analyzed according to these criteria. Of the 23 stations which were found to be more or less polluted from the biological analysis, 6 of these stations (#13, 80, 99, 132, 134, 138) showed no signs of pollution from the chemical analysis except that the CO_2 content was somewhat high. Two of these stations showed no signs of pollution from a chemical analysis (#89, 109). All of the stations studied in the Lititz Run Series except #96, were polluted, to very polluted according to the biological analysis. Lititz Run has its source in a large limestone spring, and as a result would be expected to have water high in CO_2 content. These stations were surveyed two or three times. Three of them (#106, 108, 110), two of the three times they were surveyed showed no signs of pollution except that the CO_2 content was high. One, number 122, showed no signs of pollution except for the CO_2 content, one of the three times it was surveyed. Number 104 showed no signs of pollution other than high CO_2 one of the two times it was surveyed. On the other hand, five stations (#82, 116, 153, 158, 160) which supported healthy floras and faunas had a high CO_2 content.

As to total conductivity the highest amount found was 572×10^{-6} mho. The most polluted station that we studied, #108, had a total conductivity of 528×10^{-6} mho and 478×10^{-6} mho in the two analyses we made.

The pH of all stations were within the range that Ellis believes to be satisfactory for a healthy station.

As to B. O. D., ten of the surveys of stations (#13, 2 surveys; 110; 111; 122; 132; 134, 2 surveys; 139 B) which showed an upset condition from the biological analysis, did not indicate such a situation from their B. O. D. Five biologically healthy stations had high B. O. D.'s (#28, 63, 135, 136, 153). Indeed, one station, #136, had a B. O. D. of 11.55 p.p.m. which was one of the highest found.

As a result of the work on the Conestoga, it became evident that though the usual chemical analysis as described above gives us many useful facts indicating the general conditions of a stream, it can only be used as substantiating evidence in determining the conditions of life in a stream.

The use of plants and animals in an evaluation of stream conditions has long been recognized. This is evidenced by the biological studies which accompany such surveys as the New York Survey, the Illinois River Survey, the San Joaquin River Survey, and the Ohio River Survey. Such studies have been valuable in ascertaining which streams would be suitable in the stocking of fish. In relation to pollution studies, the emphasis has been on establishing the pollution of a stream as shown by the presence of certain indicator organisms. Kolkwitz and Marsson (1908, 1909) have classified various organisms according to the degree of pollution which they indicated. They recognized four stages of pollution; polysaprobic, mesosaprobic, oligosaprobic, katarobic. Richardson (1921) and others have also stated that certain organisms are characteristic of varying degrees of pollution. However, as Ellis (1937) stated, many such indicator organisms can live in normal as well as in various polluted conditions, for rather than being specific for a given condition they are tolerant over a wide change in the environment. Therefore, he believes that it is the relative abundance of individuals of indicator species which is the important consideration. Such quantitative measurements are very difficult to achieve. At one station on the Conestoga we tried to compare the number of chironomids found on the two sides of the stream. We found that samples taken from one side of the stream in as nearly the same environment as possible were significantly different, and thus we could not make a comparison between the two sides of the stream. In using " index indicator " organisms to determine the degree of pollution of a stream, one should have many organisms representing several diverse groups. As yet not enough is known about the physiology of individual organisms so that we can be sure that their presence indicates pollution of a given quantity or quality. However, the finding of a number of organisms from diverse groups of plants and animals which all indicate the same kind of pollution, is substantial data for judging a station as polluted. One fact that becomes very apparent when one reviews the literature on indicator organisms, is that hardly ever is a whole genus characteristic of pollution, but rather it is at the species level that such index organisms can be recognized.

Many of the surveys have been based mainly on plankton organisms. As pointed out by Brinley (1943) a sudden rain will often flush out plankton. High turbidity following rain is often detrimental to plankton. On the other hand a rain may wash plankton out of a swamp or oxbow lake into the main stream, and thus cause a sudden increase in plankton. Also the constant flow of a stream will often carry plankton for some distance downstream. Slow flowing streams are more suitable for plankton development than rapid ones.

Lackey (1941) in his report on the Scioto River says that it is perhaps unfortunate that conclusions were drawn from the distribution of suspended biological forms almost to the exclusion of bottom forms. He states that there is little doubt that the peak of *Navicula* at Shadeville is influenced by the numbers swept off the bottom of the very large riffle just above this point.

From a consideration of the literature it became evident that the best type of biological measure would be one which was based on all groups of plants and animals living in the stream, particularly the sessile or attached forms or those which move about in only a small area. This meant that the most extensive collecting would be in relatively shallow water, for it is in this area that the majority of such forms live.

METHODS OF SURVEY

General Considerations

Our first problem in planning the biological survey of the Conestoga Basin was to determine its general characteristics. Dr. Jack B. Graham made a map of the basin showing the surface rock. A study was made of the gradients of the streams to locate the various types of gradients in the streams of the system. A summary of these findings are in Appendix No. 1. The United States Geological Survey furnished us with the results of the observations made by their gauging station located at Lancaster. Mr. Edward Edgerly made available the data on precipitation over the last several years. This information was very helpful in planning the times when second samplings should be made at stations. Our aim was as far as possible to sample certain stations at high and at low water. The Sanitary Water Board generously furnished us with a list of the industries which were known to discharge their effluents into the stream system. This was of value in locating the places where pollution was entering the streams.

Before sampling was started a survey was made of the system by a limnologist, a geologist and a general biologist. This group entered the stream at various points to determine its general characteristics and to note particularly points where the character of the stream seemed to change. Map No. 1 shows the points on the system which were visited during this preliminary survey.

Since the purpose of this survey was to determine if biological organisms could be used as a quantitative measure of stream conditions, it was first necessary to determine, as a basis of comparison, what were the general characteristics of the streams of the system, particularly of healthy regions. Secondly, it was necessary to study the effects of pollution on the biota of a stream. As a result stations of two types were chosen.

In choosing the type of station to determine the general conditions of a stream, a riffle, slack water, and pool were always included. These stations were placed at points which indicated the greatest variation in ecological conditions. In choosing the type of stations to determine the effect of an effluent on a stream, the ecological conditions of the stream below the entrance of the effluent were carefully studied. Particular attention was paid to the rate of flow, type of bottom, sunlight, and type of banks. A point upstream was then located which as nearly as possible duplicated ecologically the region below the entrance of the effluent. Care was always taken to make sure that a tributary did not enter between the points being compared. Map No. 1 shows all the stations which were studied in detail..

Sampling Techniques

A few days previous to the entrance of the team into a station, it was visited to make sure that no temporary abnormal change had occurred, which would make it useless as a region for study. At this time a detailed map was made which showed the limits of the station. The delimiting of the region surveyed is very important, as one of the major premises of this method is that all groups of organisms are collected at the same time in a carefully delimited area. Concurrent with this collecting, a chemical analysis of the water is also made.

During the survey of the Conestoga two teams were in operation. Each team consisted of a protozoologist, an invertebrate zoologist, an algologist, an ichthyologist, and an assistant. A chemist and a bacteriologist served both teams.

The first persons to enter a station were the chemist and bacteriologist. The chemist took one sample if the stream was small. If, however, it was large with a great variation in rate of flow in different regions, samples were taken from each type of ecological habitat. Occasionally it was deemed wise to take a composite sample. The water for dissolved oxygen was " fixed " in the field, and the pH was determined. The chemist returned at once to the laboratory and within two hours had started his analysis. Except for minor changes " Standard Methods for the Examination of Water and Sewage " (Amer. Pub. Health Assn.) was followed. The purpose of these analyses was to have a general chemical background for the biological conditions found. As seen in Appendix number 2, they included the tests usually run in stream analyses.

The bacteriologist took both water and mud samples. These were usually composited samples. Total bacterial counts, coliform counts and types of species were determined. It was not feasible to make bacterial counts at all stations sampled, but the results obtained are recorded in the brief description which accompanies each station chart. This work was carried on under the direction of Dr. Robert W. Stone, Pennsylvania State College.

As soon as the bacteriologist and water chemist were out of the stream, the qualitative collecting was started. Each person was assigned certain groups which he was to collect during the summer. The aim of the qualitative collecting was to obtain all species which were established in the station, for it is only those organisms which are established in a given environment that can be used as indicators of an environment. No effort was made to collect single individuals or to get a maximum fauna or flora. Particular effort was made to collect in all types of habitats within a station for each group of organisms. In the case of the insects the Needham scraper was very useful. Net sweepings of the banks were also made to secure adults. In some cases such as chironomids, the larvae were reared in the laboratory in order to obtain adults. The use of traps for various groups of organisms was not practical, for with the large scope of our work it was impossible to repeatedly revisit a given station. As such a study is a comparative one, and based upon similar sampling at all stations, such a procedure unless carried out at all stations would be of little use in trying to set up relative standards of conditions. Traps would of course have given us more complete information. The collection of protozoa was made from all possible habitats. In deeper water the use of the aspirator bottle was found very useful. The collection of algae was confined to those placed where a visible amount was evident, the theory being that because the microscopic forms can easily be carried about, one could get an erroneous idea of the species which were characteristic of an area unless such species had reproduced enough to form what is often referred to as an " algal bloom ".

The fish were collected for the most part by means of seines. The 20 ft. bag seine was found most useful. The use of an electric shocker was not attempted as the water of most of the streams of the Conestoga Basin is very muddy.

Plankton tows were taken at each station. They were semi-quantitative as the same amount of water was put through the plankton net at each station. No well-developed plankton was found to exist in the streams of the Conestoga Basin. Most of the organisms found were attached or bottom forms which had been dislocated and were being carried downstream. This is no doubt due to the fact that the streams of the system are shallow and for the most part swift.

The plankton net was found useful in collecting rotifers and protozoa from the marginal water of the stream.

The bottom samples were collected by means of the Ekman and Petersen dredges. At each station a transect was made over each type of river bottom. The samples from a given transect were composited and a gallon aliquot taken back to the laboratory. Here a given weighted amount was washed, and the different kinds of organisms sorted and counted.

An attempt was made to approximate the cubic feet per second of water in the streams of the Conestoga Basin. At first a float was used to determine rate of flow, but due to the large number of obstructions in the streams, it was found that fluorescein is more efficient. A handful is put in the water near the upstream limit of the station. The length of time for the color to reach a point 100 ft. downstream is then clocked. Such a method is very rough, and can only be used for comparative purposes.

Identification of Specimens

On returning to the laboratory the identification of specimens collected was started at once. An effort was made to determine them before collections were made at another station. In this way no great backlog of unidentified material accumulated. For this work the resources of the Academy of Natural Sciences were very valuable. Their collections of plants and animals which contain many types and a great deal of authenticated material were used for comparative purposes. The library with its great wealth of taxonomic literature proved most helpful. When specimens were found which could not be identified with the facilities at hand they were sent to the various scientists who are listed under scientific consultants in Appendix 5. In order to make this rapid identification possible assistants were used to sort material, make slides, and help with mechanical details. Identifications were carried to the species level.

A rough approximation was made of the frequency of each species, and noted as follows: 5, very abundant; 4, common; 3, frequent; 2, few; 1, rare. Because a stream consists of so many small and diverse habitats, and because it is so hard to determine macroscopically the limits of an environment of a microscopic organism, it was impossible to try to set up an accurate quantitative measure of the number of individuals found. Further research is greatly needed to determine if a reliable quantitative method can be worked out.

A report was turned in as soon as all the identifications, except those which were sent away for determination, were made. The results of such determinations were added later. Each report included a list of the species found, an approximation of their abundance, and ecological notes as to where they were found. Wherever possible specimens of each species were preserved for future comparison and checking. These will be deposited in the respective collections of the Academy of Natural Sciences of Philadelphia.

The groups which were collected at all stations and identified to species were; algae, flowering plants, fish, insects, the Malacostraca of the Crustacea, the Platyhelminthes and the Hirudinea of the worms, the mollusks except for the Sphaeriidae, the rotifers, the sponges, the bryozoa, the coelenterates, the protozoa, and the bacteria. The fungi were not considered except at stations where they were found to be abundant.

Detailed reports on the taxonomy and ecology of the various groups determined will be published later. The number of species and subspecies identified in each of the groups is as follows; Bacteria 49, Algae 230, Angiosperms 32, Protozoa 361, Porifera 3, Coelenterata 2, Platyhelminthes 3, Rotifera 56, Annelida 21, Crustacea 19, Insecta 247, Mollusca 29, Pisces 47.

Compilation of Results

The reports from the various stations were made into a chart which listed the species found at each station. It became apparent after studying these charts that the number of species of each of the taxonomic groups varied greatly in the different types of stations studied. In some cases this was due to obvious ecological factors such as low temperature. However, most often a reduction in species number seemed to be correlated with the degree of pollution, because actual tests made from as nearly equal ecological environments as possible above and below the entrance of an effluent showed this type of change. This reduction resulted in the sensitive organisms being eliminated and only the more tolerant ones remaining. A few organisms such as the rat-tail maggot and *Sphaerotilus* occurred only under polluted conditions. Such organisms are useful for confirming conclusions as to the condition of a stream. In the Conestoga Basin a few groups seemed to have more species present in somewhat polluted conditions or the species grew much better under such conditions. Such groups were as follows: algae—blue-green algae, green algae—*Stigeoclonium, Spirogyra,* and *Tribonema;* rotifers—the bdelloid rotifers plus *Cephalodella megalocephala* and *Proales decipiens;* worms—oligochaetes, and leeches; mollusks —pulmonate snails.

Our problem was to see if the change in the total number of species of each taxonomic group could be used as a biological measure of stream conditions. To do this we tried to determine which of our stations on the Conestoga System were normal or healthy stations. This was ascertained by examining the chemical, bacteriological, and biological data. Nine stations were found which according to these criteria and ecological conditions were typically healthy stations. The averages of the number of species in each taxonomic group for these nine stations were used as a basis of this study.

Because certain groups behaved similarly in response to a given environment they were grouped together in the following columns.

Column one: the blue-green algae, and the following genera of green algae, *Stigeoclonium, Spirogyra,* and *Tribonema;* the bdelloid rotifers plus *Cephalodella megalocephala* and *Proales decipiens.*

Column two: Oligochaetes, leeches, and pulmonate snails.

Column three: Protozoa.

Column four: Diatoms, red algae, and most of the green algae.

Column five: all rotifers not included in column one, plus clams, prosobranch snails, and tricladid worms.

Column six: all insects and crustacea.

Column seven: all fish.

As the best way to express these results seemed to be a histogram, the average number of species in these nine stations for each column was obtained and set as equal to 100%.

It will be noted that the bacteria are not included on the chart. The reason is that the number of species of bacteria present do not seem to vary with the presence or absence of pollution. Likewise the kinds of species do not change. This may be due to the fact that the basis of classification of the bacteria is very different from that of other groups of plants and animals. The total count of bacteria and the coliform count did vary in the presence of pollution, particularly organic pollution. However, fairly high bacterial counts were found in healthy stations. As pointed out by Dr. R. W. Stone, who was in charge of the work with bacteria, a normal stream water may have a bacterial flora as high as 10,000 per ml. These facts have been used in the qualitative consideration of the stations.

The fungi are also not included because a complete study of them was not attempted. It was only when they occurred in great numbers that they were identified and used as qualitative indicators.

The flowering plants were not included in the charts because, according to Dr. Fassett, qualitatively and quantitatively they did not seem to change with the degree of pollution of a stream.

The species, except those mentioned above, which were found at each of the stations studied were then grouped as described. The total number of species found in each group was then expressed as a percent of the number found in an average normal station.

The histograms and descriptions of the various stations are given in Appendix 4. It will be noted that these histograms seem to fall into four general groups which we have designated as healthy, semi-healthy, polluted, and very polluted. These in some ways correspond to the grouping of stations by Kolkwitz and Marsson (1911), Forbes and Richardson (1913), Richardson (1921-1925), Sutter (1922), Fair and Whipple (1947), but differ in that the basis of their groupings were conditions resulting for the most part from the effect of sanitary wastes. Such conditions produce a zone, designated as " septic ", " polysaprobic " or " the region of active decomposition ", in which the B. O. D. is very high and the dissolved oxygen is depleted due to decomposition. The conditions of pollution which we studied were for the most part due to the toxic effluents from industries. There were some stations where active decomposition due to sanitary or organic industrial wastes was occurring such as 133A (July sampling), when a very high bacterial count was found and a luxurious growth of *Sphaerotilus* covered the rocks.

However, the most damaging effect on plant and animal life was a toxic agent rather than the result of depletion of dissolved oxygen. We did not find the dissolved oxygen to be so low at any station that it would be definitely limiting. In the region where the most toxic conditions existed, plant and animal life were completely wiped out. Recovery started when dilution or chemical change in the toxic agent had occurred to such a degree that the more tolerant plants and animals could live. In some cases due to dilution of the effluent before or at the time of entering the stream, the " polluted " condition was the most toxic condition found. This stage which we have described as polluted corresponds to " the zone of recovery " of Whipple and Fair (1947) and Sutter (1922), " the polluted zone " of Forbes and Richardson (1913), Richardson (1921-1925), and the " mesosaprobic zone " of Kolkwitz and Marsson (1911). The zone which we have designated as healthy is " the zone of cleaner water " of Fair and Whipple (1947), Sutter (1922), Forbes and Richardson (1913), Richardson (1921-1925), and " oligosaprobic zone " of Kolkwitz and Marsson (1911).

The stage which we designate as semi-healthy is not recognized in previous classifications of streams. This is the condition in which deterioration is just starting or recovery is almost complete. This stage is the most difficult to recognize, but is characterized by an unbalanced condition which is evidenced by the overdevelopment of one species or by the great increase in species number of some groups while others are decreasing.

Within each of these designated stages or zones there is a great deal of variation. This is to be expected, for very divergent ecological conditions existed, i.e. difference in size of streams (breadth variation from a few feet to over 100 feet); rate of flow; time of sampling in relation to rain fall; variation in pools which were suitable habitats for fish. Further studies will be needed to refine these patterns, and to determine just what types of ecological variation are most significant. The important consideration is the relative heights of the various columns to each other rather than the absolute height of any one column.

It will also be noted that some of the groups such as semi-healthy and healthy seem to more or less grade into each other. Theoretically this would be expected, for what we have is a continuous process upon which we have superimposed an arbitrary classification. This continuous gradation is most clearly seen when a stream is being rejuvenated or brought back after pollution. This type of gradation would have shown up clearly, particularly on Little Muddy Creek, had our sampling stations been closer together. It is in the classifying of such border-line stations that qualitative indicators become very useful.

There are, however, definite characteristics which make up these classes or groupings. Due to the fact that a condition represents a band rather than a point on a continuous scale, two or more statements have to be made to define the limits.

A " healthy " stream is one which has a balance of organisms, or the biodynamic cycle is such that conditions are maintained which are capable of supporting a great variety of organisms. The algae are mostly diatoms and green algae, such as *Cladophora crispata* and *glomerata,* and the insects and fish are represented by a great variety of species. There are also numerous species of protozoa, but as their coefficient of variation was large, they were not a good group to use in defining a station. Columns one and two were found to vary greatly depending on the ecological conditions and degree of enrichment of a station. Thus a healthy station was found to be one in which columns 4, 6, 7 were all above the 50% level. (See figs.)

" Semi-healthy " is the condition in which the balance of life as described for a healthy station has been somewhat disrupted but not destroyed. Often a given species will be represented by a great number of individuals. This condition is noted in the histograms by a double width column. Something has happened which has destroyed the check on this species. Under other circumstances conditions have altered so that a certain group will have a great many more species present than usually occur, while other columns will be greatly depressed. Thus the pattern is an irregular one. It may be defined as follows:

1. Either or both columns 6 or 7 below 50%, and column 1 or 2 under 100%.
2. Either column 6 or 7 below 50%, and columns 1, 2, and 4 100% or over: or columns 1 and 2 100% or over and column 4 double width. (See figs.)

" Polluted " is the condition in which the balance of life found in a healthy station is upset. However, conditions are favorable for some groups of organisms such as those represented in columns one and two. Such a condition may be defined as follows:

1. Either or both of columns 6 and 7 are absent, and columns 1 and 2 are 50% or better.
2. Columns 6 and 7 are both present, but below 50%, then columns 1 and 2 must be 100% or more. (See figs.)

" Very polluted " is a condition which is definitely toxic to plant and animal life. Often many groups are absent. It may be defined as follows:

1. Columns 6 and 7 are absent, and column 4 is below 50%.
2. Column 6 or 7 is present, then 1 or 2 is less than 50% (see figs).

Besides these four classes there was a group of stations which we have labeled atypical because they could not be compared, either due to general ecological conditions or to methods of collection, to the healthy stations which were used as a basis of these histograms. By such general ecological conditions, I refer to the fact that the normal stations were in eutrophic conditions, thus stations in cool oligotrophic water could hardly be rated on the same basis. Likewise a stream with steep newly eroded banks would not be comparable with a normal stream with shallow water near the edges. Sometimes local obstructions or accidents prevented thorough collection and thus rendered a station uncomparable. Further work will eliminate these differences, for comparable bases will be worked out for various types of ecological conditions and collecting methods will be perfected.

It is interesting to compare the change in patterns of the following types of streams from headwater to mouth.

1. A stream which is only polluted by sanitary wastes from farmyards and small towns.

2. A stream which receives a large amount of sanitary wastes and industrial effluents but recovers.

3. A stream which never completely recovers after receiving industrial effluents.

Let us first consider *Hammer Creek*. See map 1, figs. 1-6. These stations were all sampled during the latter half of August. This stream is apparently free of industrial pollution. The stream receives the sanitary wastes of small towns and farms. The common practice of the washing out of spray tanks into the stream was practiced at bridges crossing it. These sources of pollution may account for the irregular trends seen in the development of some groups of species. Most of the water of Hammer Creek comes from springs found at stations 152, 153. Station 152 was in a farmyard, and the stream at this point is a large very cold spring arising out of limestone rock. It flows through a chicken yard. Station 153 is in a pasture. At station 116 the temperature has risen from 11° to 15°C. As these collections were made in August this may well be the highest temperature reached at these stations. Stations 146, 147, and 28 represent warm eutrophic stream conditions. All of the stations except 152, which is atypical, are healthy stations. It will be noted that the number of insect species increase from headwater to mouth. The fish show this same general though somewhat irregular trend. The low number of fish at station 116 is due to the fact a large tree had fallen over the largest pool, and made it unseinable. The diatoms etc., remain relatively constant throughout the stream system. Their variation is no doubt due to ecological conditions. The protozoa also show a steady increase from headwater to mouth. Columns one and two behave erratically, as often happens in healthy stations. Thus in those groups which are important in maintaining the balance of life in a stream there is generally an increase from headwater to mouth. The very irregular appearance of these healthy station patterns indicate that minor pollution or ecological variation may alter considerably the behavior of the various groups, but columns 4, 6, and 7 are always within the limits of a healthy station.

Little Muddy Creek is represented according to geographic sequence, Map 1, figs. 12-27. This stream in many respects is quite similar to Hammer Creek, and should support somewhat similar stream conditions if it were not for industrial pollution, which enters the stream just below station 131 and at irregular intervals to below station 139.

The headwater station 138 is on the borderline between healthy and semi-healthy conditions. There is evidence as shown by qualitative indicators, such as an abundance of *Nitzschia palea, Philodina citrina* and Chironomidae, of organic pollution due to sanitary wastes. At station 131, which is approximately ¾ mile downstream, healthy conditions are found. Just below station 131 the effluent from a hat factory enters the stream. Although this is an industrial waste, there was a great amount of organic matter in it, which caused the stream to degenerate to a polluted condition. The stream bed was covered with *Sphaerotilus* and the bacterial count was very high. About a half mile downstream, recovery had taken place to such an extent that semi-healthy conditions were approached. Considerable sulphate and calcium had entered the stream in this distance, but they did not seem to have as deleterious an effect on plant and animal life as the effluents found at station 133. Just below station 138 more effluents enter the stream. They are from a settling basin of a hat factory, but seem to be of such a nature that they do not change the stream conditions. At station 136, which is approximately 3 miles downstream from station 139, recovery seems to have been completed though the sulphates are still about 100 p.p.m. At this point the stream seems to be teeming with life as a result of ideal ecological conditions and the decomposition of the organic enrichment which it has received upstream. Particularly numerous are the organisms which make up columns 2, 3, and 5.

Station 135 which is approximately two miles downstream from station 136 is also a healthy station, but the fauna and flora have been depressed due to the heavy silt load which the stream periodically receives just above this point of sampling. This is caused by the steep banks which exist on both sides of the stream and the careless farming practiced there. The fauna and flora as well as the bacterial and chemical analyses indicate conditions have returned to normal. However, considering the size of the stream, conditions are not as favorable for plant and animal life as at station 131 before pollution entered the stream. Nor were they as favorable, all things considered, at station 136 as at station 131. Thus it would appear that although the stream recovers it is not as healthy as before pollution entered the stream. When compared with station 28 of Hammer Creek, which is also located near the mouth of a stream, it is noticeable that the number of species in columns 4-7 is less, while those in columns 1 and 2 are more, and column 3 is about the same. Likewise in comparing stations 136 and 28, the picture is much the same except that column 3 is longer in 136 than station 28. On the other hand the Lititz Run Series never recover from the effects of pollution which enter Lititz Spring Run and Lititz Run approximately five miles above its mouth, although several tributaries with healthy fauna and flora empty into it. Thus it is evidenced that the type of pollution makes a great deal of difference in the rate of recovery of a stream.

The question arose as to whether this system of measure would hold through the various seasons of the year. Due to limited funds it was impossible to carry out the survey in entirety throughout the year. Therefore certain stations were chosen which represented healthy, semi-healthy, polluted and very polluted conditions, and surveyed during the fall months. It is a known fact that the abundance and kind of species often varies according to the season, but whether the total number of species, which were established in a given environment, would vary to any great extent needed to be determined.

The basis of comparison of the number of species of each group found at the stations collected during the fall was the normal summer healthy station. It is interesting to note that the percentage of change was not very great for any one group. Thus, though the heights of the columns were shortened, they were for the most part in proportion to each other. The kinds of species varied much more greatly, changing from thirty to fifty percent depending on the group.

It is apparent that this biological measure based on total number of species does hold, since most of the patterns found during the summer remained characteristic of fall conditions. Of the twelve stations studied during the fall which had summer records, two, 139A and 139B, shifted. The first shifted from semi-healthy to polluted, and the second from semi-healthy to very polluted. The chemical analysis of the water seemed to indicate that these were shifts in condition of pollution rather than due to seasonal change. In no case did a healthy pattern change to polluted or vice versa. However, more work needs to be done.

It should be emphasized that though the main basis of the biological measure of stream conditions as set forth in this paper is based on number of species found, one must take into consideration ecological conditions and qualitative indicators. Indeed the safety of this method lies in the multiplicity of its approaches.

CONCLUSIONS

The results of this study indicate that under healthy conditions a great many species representing the various taxonomic groups should be present, but no species should be represented by a great number of individuals. This is what biologically one would expect, for healthy conditions should offer habitats suitable to many different species. Competition would be severe and minor differences in ecological conditions would serve as barriers in determining varying ecological niches, and permit survival.

A pollutant would eliminate many species, thus the few which did survive would have less competition, and more chance for multiplication. The result would be the first effect of toxicity or a pollutant, a reduction in species number and a great abundance of those remaining. Some groups would be more severely affected than others. More severe toxic effects would result in the complete elimination of some groups, and a reduction in species numbers in other groups. Very severe toxic conditions would kill all organisms. Thus the general effect of pollution seems to be a reduction in species number with the most tolerant forms surviving.

SUMMARY

To summarize, the biological measure of stream conditions as just described is sound for a number of reasons.

On the premise that the biodynamic cycle or in other words the balanced physiological activities of aquatic life in surface waters is essential for the maintenance of healthy water conditions, then we may assume that the most direct measure of this biodynamic cycle will tell us what is the condition of the water. This measure tells us the presence or absence of species of all major taxonomic groups that play a role in this cycle with the exception of the bacteria, which are considered as to total count, and fungi, which were treated only as indicator organisms.

The chemical and physical characteristics of normal healthy streams vary widely and cannot be reduced to a simple standard. Furthermore we have no practical means of testing for all possible toxic agents that may be present in a stream, and it is seldom that a single agent acts independently as a limiting factor, but rather it is the interaction of all factors present in a given environment.

This measure, which uses largely the organisms that are attached to the bottom or edges of the stream, will reflect the water conditions that have flowed by a given point for a considerable time before sampling, whereas a chemical analysis can only tell us the condition at the exact time it was taken. The bases of this measure are the healthy stations of the stream system being measured and not an arbitrary standard.

BIBLIOGRAPHY

BRINLEY, FLOYD. 1943. Ohio River Pollution Control. Report of the U. S. Ohio River Committee. Part 2, Supplement.

ELLIS, M. M. 1937. Detection and Measurement of Stream Pollution. U. S. Bureau of Fisheries, Bull. 22.

FORBES, S. A. AND R. E. RICHARDSON. 1913. Studies of the Biology of the Upper Illinois River. Bull. Ill. Nat. Hist. Survey, vol. 9, pp. 481-574.

KOLKWITZ, R. 1911. Biologie des Trinkwasser, Abwasser und der Vorflutes. Rubner, Gruber and Ficker, Handbuch der Hygiene, II, 2. Leipzig, S. Hirzel.

KOKLWITZ, R. and M. MARSSON. 1908. Oekologie der pflanzlichen Saprobien. Ber. d. Deut. Bot. Gesell., vol. 26 a, pp. 505-519.

————. 1909. Oekologie der tierischen Saprobien. Int. Rev. d. ges. Hydrobiologie u. Hydrographie, vol. 2, pp. 126-152.

LACKEY, J. B. 1941. Planckton Studies; in A Study of the Pollution and Natural Purification of the Scioto River, by Robert W. Kehr, W. C. Purdy and James B. Lackey. U. S. Pub. Health Service Bull. 276, pp. 80-99.

RICHARDSON, R. E. 1921. Changes in the Bottom and Shore Fauna of the Middle Illinois River and Its Connecting Lakes Since 1913 to 1915 as a Result of Increase, Southward, of Sewage Pollution. Bull. Ill. Nat. Hist. Survey, vol. 14, pp. 33-75.

————. 1925. Changes in the Small Bottom Fauna of Peoria Lake 1920-22. Bull. Ill. Nat. Hist. Survey, vol. 25, pp. 391-422.

SUTER, R. AND E. MOORE. 1922. Stream Pollution Studies. New York State Conservation Commission.

APPENDIX 1

THE GEOLOGY OF THE CONESTOGA BASIN

By JACK B. GRAHAM
Research Associate, Department of Geology,
Academy of Natural Sciences of Philadelphia

The Conestoga Basin contains 474.8 square miles embracing portions of Berks, Lebanon, Chester and Lancaster Counties. Much of the area is gently rolling agricultural lands ranging in elevation from about 350 to 450 feet. The lowest point in the basin, the mouth of the Conestoga Creek, lies slightly below the 180 foot contour. The highest land occurs along the northern and eastern borders, at elevations between 1100 and 1200 feet.

The bedrock of the basin is composed chiefly of limestone, dolomite, and shale of Cambrian and Ordovician age, with lesser amounts of Triassic conglomerate, sandstone and shale. In the southern and eastern border areas of the basin, metamorphism has altered small areas of Cambrian sediments to quartzite, phyllite, slate and marble. Minor areas in the northern portion are underlain by Triassic diabase, an igneous rock.

The harder rocks, the quartzites, phyllites, slates and diabase, offer the greatest resistance to erosion and occupy the highlands of the border areas. Conglomerate and sandstone, and to some extent shale, account for the sharper relief within the basin. The limestones and dolomites and some of the softer shales are easily worn down by the processes of atmospheric decay and erosion, and occupy the lowlands that form a large part of the basin. The major streams have developed valleys ranging in depth from 50 to 200 feet, the latter depth being reached only by Conestoga Creek near its mouth.

The gradients of Conestoga Creek and its major tributaries reflect the geologic conditions traversed by the streams. Conestoga Creek, 61.5 miles long, has its source in Triassic conglomerate, and in the 5.5 miles of the stream above 500 feet elevation, falls at the rate of 78.2 feet a mile. From an elevation of 500 feet to the mouth at 175 feet, the stream flows on limestone or dolomite with a drop of 325 feet in 56 miles, an average gradient of 5.8 feet to the mile.

Cocalico Creek is predominantly a south-flowing stream and crosses the outcrops of several formations. The stream is 25.1 miles long. For 1½ miles below the source, it flows over resistant Triassic conglomerate. It crosses a soft shale valley in the next mile and a half, with a corresponding reduction in gradient. For the next 5½ miles the stream cuts through hills of conglomerate and shale, entering a broad limestone plain at elevation 390. From this point to the mouth, a distance of 17 miles, the stream flows on limestone, except for about 1 mile of shale.

In the 8 miles from the source to the limestone plain, the stream has an average gradient of 75 feet to the mile. Throughout the remaining 17 miles of its course, the average gradient is 6.5 feet to the mile.

Mill Creek, which is 25.5 miles long, originates in Cambrian quartzite and other highly resistant rocks of Welsh Mountain. From the source to elevation 400 feet, the gradient is steep, averaging 115 feet drop per mile for 5 miles. After crossing the last highly resistant formation at about 400 feet elevation, the gradient for the 20.5 miles through limestone and dolomite terrain to the mouth averages 8.0 feet to the mile.

Hammer Creek, which is 18.1 miles long, is characterized by a relatively moderate but variable gradient. The source occurs in Triassic diabase on the north flank of Furnace Ridge. The stream flows north down the steep diabase ridge, swings east a short distance along a limestone plain, and turns abruptly south through the Triassic ridge, crossing diabase, conglomerate and shale. On the south side of the ridge, Hammer Creek flows over Ordovician shale to a point 4½ miles from the mouth; the remaining section of the stream flows over limestone. From the source to the Triassic shale contact on the south flank of the ridge, the average gradient per mile is 56.6. From the same contact to the mouth, about half the length of the stream, the gradient is 11.7 feet to the mile.

The profile of Middle Creek suggests that this stream elongated itself in geologically recent time by the capture of headwater drainage formerly a part of Cocalico Creek. Middle Creek, but 12.1 miles long, originates on a hillside of Triassic conglomerate and for 3 miles flows with a gentle gradient over soft Triassic shales. It then descends precipitously through a canyon-like gap cut in sandstone and conglomerate of Furnace Ridge and reaches Ordovician shale at a point about 5 miles below its source. The last 5¼ miles of its course is over limestone. It is probable that the stream originally headed on the south flank of Furnace Ridge and was about 8 miles long. As erosion of Furnace Ridge continued, the source migrated north to finally join a headwater tributary of Cocalico Creek north of the ridge. Because of the lower topographic position of Middle Creek, it was favored over Cocalico Creek and diverted several square miles formerly belonging to the Cocalico Basin. The resulting stream profile is a combination of two streams. Middle Creek falls 80 feet in the first mile and averages 15 feet per mile for the next two. From this point, it cuts through Furnace Ridge, falling 70 feet per mile for two miles. The remaining distance to the mouth has an average gradient of 10.7 feet to the mile.

The six-mile-long Indian Run heads in conglomerate of Furnace Ridge and falls 280 feet in the first half mile. Two and one quarter miles below its source, it enters a limestone plain and has a gradient of 15.8 feet to the mile for the remaining 3¾ miles of its course.

The 20-mile-long Little Conestoga Creek originates in hard shale hills and falls 120 feet in the first mile. Thereafter the flow is entirely over limestone or dolomite and from one mile below the source to the mouth averages 11.3 feet to the mile.

Little Muddy Creek, 10.3 miles long, is notably consistent in the steepness of its gradient throughout its course. Its entire length lies on Triassic formations composed of diabase, conglomerate, sandstone and shale. Changes in the underlying rocks are not noticeably reflected in changes in gradient. The upper 4 miles has an average gradient of 63.4 feet to the mile while the lower 6¼ miles averages 20.9 feet to the mile. Of particular significance is a mile and a half segment of Little Muddy Creek beginning about one-half mile above the mouth. In this portion of its course, the stream flows along the strike of soft Triassic shales which border a high ridge of hard sandstone on the one side and a tongue of diabase on the other. The steep slopes of the shale valley, caused by the resistant rocks on either side, have resulted in severe valley erosion. The gain in the silt load of the stream in this segment is visibly great. In this short stretch of Little Muddy Creek, topographic conditions, together with easily eroded bedrock, have combined to produce the most serious area of soil denudation observed in the entire Conestoga Basin.

Lititz Run is 9 miles long. The first one-half mile of its course lies in resistant shale. It then flows over limestone and dolomite formations for 5 miles, follows a fault zone through a mile-wide belt of shale, and again flows over limestone or dolomite for the remaining two and one-half miles. Except for the headwater shale area, the gradient is moderate. Lititz Run falls 125 feet in the first mile and from there to its source averages 21.9 feet to the mile.

With the exception of Middle Creek, the stream profiles of the several water courses described are typical of a topography in early maturity. The streams have moderately steep headwater gradients but quickly attain gentle rates of fall. However, the Conestoga Basin is undergoing more rapid erosion at the present time than was true in the past. The lower course of Conestoga Creek exhibits incised meanders, showing that aggradation in the past has been replaced by more recent deepening of the channel. Erosion is still active, particularly in those sections of the streams underlain by soft shale.

APPENDIX 2

Chemical Analyses

By John M. Ward

HAMMER CR

	Summer	*Summer*	*Summe*	*Summer*	*Summer*	*Sum*
Stati	152	153	116	147	146	. .
Hard	8.00	185.00	128.00	156.00	144.00	157.00
Alka	9.00	160.00	144.00	124.00	125.00	133.00
pH	7.2	7.7	7.7	7.8	7.8	7.8
Calcium (p.p.m.)	56.30	56.00	50.00	45.60	48.20	51.10
Magnesium (p.p.m.) .	11.75	10.90	0.70	10.20	5.82	7.10
Nitrogen (N as NH$_4^+$)	0.014	0.020	0.017	0.058	0.058	0.40
Nitrogen (N as NO$_2$)	0.0000	0.0160	0.005	0.0130	0.0100	0.011
Nitrogen (N as NO$_3$)	0.116	0.126	0.114	0.045	0.060	0.03
Phosphorus (P as PO$_4$	0.00	0.011	0.030	0.022	0.026	0.02
Iron (p.p.m.)	0.13	0.258	0.500	0.438	0.466	0.26
Silica (p.p.m.)	9.77	9.86	9.86	9.25	9.02	8.26
oride (p.p.m.)	3.8	3.0	2.4	5.0	5.4	5.6
Sulphate (p.p.m.)	12.0	12.0	13.2	8.8	8.0	8.0
Carbon dioxide (dissol	22.0	6.7	5.5	3.9	3.9	3.5
Oxygen (dissolved) (p.p.	9.04	10.20	. . .	9.20	9.36	10.40
Suspended Solids (p.p.m.	0.5	21.2	10.7	. . .	15.4	8.0
Turbidity (p.p.m.)	1.2	8.8	10.7	12.5	19.9	12.0
Temp. (C.°)	1.0	13.8	15.2	18.1	20.9	21.5
Total Cond. (× 10^{-4} mhc	3.89	3.79	3.40	3.22	3.22	3.

COCALICO CREEK

	Summ	*Summer*	*umme*	*Summe*	*Summer*
Stations	156	154	155	158	160
Hardness Total (p.p.m.	50.00	47.00	52.00	105.20	156.00
Alkalinity (p.p.m.) ..	33.60	36.00	37.40	82.00	137.60
pH	7.4	7.3	7.6	7.4	7.7
Calcium (p.p.m.) .	13.70	14.60	14.10	28.70	50.30
Magnesium (p.p.m.) . . .	3.81	2.70	4.10	8.14	7.41
Nitrogen (N as NH_4^+) (p.p.m.	0.01	0.008	0.008	0.020	0.054
Nitrogen (N as NO_2) p.p.m.)	0.00	0.0000	0.000	0.009	0.0140
Nitrogen (N as NO_3) p.p.m.)	0.73	.245	0.298	0.149	0.111
Phosphorus P as PO_4 (p.p.m	0.02	.018	0.016	0.013	0.051
Iron (p.p.m.)	0.23	.578	0.364	0.372	0.653
Silica (p.p.m.)	13.60	.05	11.10	6.89	6.34
Chloride (p.p.m.)	1.4	.8	0.4	5.2	6.4
Sulphate (p.p.m.)	10.0	.0	10.0	9.2	10.8
Carbon dioxide (dissolved (p.p.m	2.8	.6	1.9	6.9	5.8
Oxygen (dissolved (p.p.m	7.84	.16	9.20	6.40	8.16
Suspended Solids p.p.m.)	0.8	.2	14.6	27.1	16.1
Turbidity (p.p.m.)	7.7	.5	24.9	29.2	23.4
Temp. (C.°)	23.0	.8	21.5	24.3	22.2
Total C . (× 10 mhos	1.03		1.211	2.210	3.580

CONESTOG EK

	July	*July*	*August*	*August*	*August*	*Fall*
Stations	16	13A, 13D	20	*16*	*13A, 13D*	*20*
Hardness Total (p.p.m.)	144.00	164.00 160.00	184.00	152.80	174.00 172.00	58.80
Alkalinity (p.p.m.)	146.00	143.00 142.00	146.00	135.00	143.00 146.00	45.40
pH .	7.8	7.6 7.6	7.8	7.8	7.7 7.6	7.8
Calc p.p.m.	35.30	41.50 41.00	49.00	47.00	49.40 50.60	49.70
Mag n (	13.77	14.60 13.90	14.60	8.50	12.30 11.20	8.41
Nitr (N	0.062	0.096 0.115	0.023	0.009	0.011 0.023	0.067
Nitrogen (N as NO_2) (p.p.m.)	0.0320	0.0298 0.0320	0.0220	0.018	0.0200 0.0210	0.0156
Nitrogen (N as NO_3) (p.p.m.)	0.122	0.520 0.350	0.143	0.117	0.320 0.170	2.405
Phosphorus (P as PO_4) (p.p.m	0.018	0.015 0.007	0.016	0.051	0.046 0.041	0.165
Iron (p.p.m.)	0.960	0.427 0.447	0.280	0.788	0.880 1.060	0.143
Silica (p.p.m.)	6.14	5.06 5.13	5.74	8.12	5.26 5.52	6.72
Chloride (p.p.m.	4.4	4.4 4.6	4.6	4.0	8.0 9.4	6.8
Sul ate (p.p.m.	14.0	8.4 10.0	11.6	9.6	12.0 12.0	12.0
Carbon dioxi (d ed) (p.p.m	4.5	7.0 6.9	4.8	4.0	5.8 5.7	4.6
Oxygen (dissolved) (p.p.m.	7.28	6.50 7.00	7.60	8.80	6.48 7.12	11.52
Suspended Solids p.p.m	58.4	68.3 91.7	9.4	42.2	50.8 50.8	....
Turbidity (p.p.m	103.8	61.7 119.0	14.2	70.0	61.3 60.9	22.8
Temp. (C.°)	23.5	22.8 23.1	23.7	22.8	21.2 21.0	10.0
Cond. 0^{-4} mh	3.99	3.55 3.61		3.55	3.56 3.69	

Sul indicated by letters B, C, D.

	CON			CONESTOGA	
	Fall	*Fall*	*Fall*	*Fall*	*Fall*
	18	9	169	63	5
Total (p.p.m.	3.20	161.20	85.20	222.00	86.80
ty (p.p.m.)	6.00	157.60	42.00	188.00	66.30
...	7.8	7.6	7.6	8.1	8.2
(p.p.m.) .	1.50	64.50	21.90	54.90	55.50
m (p.p.m.)	0.80	11.90	6.93	20.70	11.70
(N as NH_4^+ (p.p.m.	0.055	0.122	1.040	0.268	0.087
(N as NO_2) p.p.m.)	0.016	0.0570	0.005	0.0270	0.011
(N as NO_3) p.p.m.)	2.280	1.505	5.320	2.590	3.81
us (P as PO_4 (p.p.m	0.052	0.044	0.002	0.004	0.00
p.p.m.)	0.197	0.486	0.177	0.135	0.09
(p.p.m.)	5.41	4.93	10.76	6.22	5.99
de (p.p.m.	7.0	8.2	6.6	4.4	8.4
te (p.p.m.	0.0	10.4	15.6	8.0	11.4
dioxide (d ved) (p.p	4.6	7.4	2.2	4.0	0.0
(dissolved) p.p.m.	9.76	4.68	9.04	10.64	10.00
ty (p.p.m.)	2.8	42.3	45.7	164.4	11.6
(C.°) ...	0.5	21.9	14.0	14.0	13.0
nd. (×		3.65			

LITTLE MUDDY CREEK

	Summer	Summer	Summer	Summe	Summer	Summer
———	138	131	132	134	37A, 137B	39A, 137B
Hardness Total (p.p.m.)	49.00	56.00	6.00	54.00	108.00 80.00	84.00 132.00
Alkalinity (p.p.m.)	49.00	52.00	100.00	107.00	73.60 68.00	64.00 52.00
pH	7.5	7.4	6.9	7.2	7.6 7.4	7.2 6.9
Calcium (p.p.m.)	11.30	16.80	20.00	14.50	39.20 31.40	32.80 31.60
Magnesium (p.p.m.)	5.00	3.40	8.20	4.50	2.40 0.39	0.58 19.20
Nitrogen (N as NH_4^+) (p.p.m.)	0.045	0.025	0.077	0.03	0.570 0.470	0.181 0.904
Nitrogen (N as NO_2) (p.p.m.)	0.0040	0.0010	0.0160	0.00	0.0140 0.0012	0.0080 0.0130
Nitrogen (N as NO_3) (p.p.m.)	0.487	0.252	0.312	0.26	0.250 0.238	0.187 0.207
Phosphorus (P as PO_4) (p.p.m.)	0.028	0.022	0.292	0.06	0.070 0.068	0.050 0.120
Iron (p.p.m.)	0.388	0.144	0.235	0.24	0.280 0.206	0.353 0.364
Silica (p.p.m.)	15.20	14.80	9.20	15.00	13.60 14.00	13.90 14.50
Chloride (p.p.m.)	0.0	1.6	3.6	2.0	6.4 3.0	4.6 4.0
Sulphate (p.p.m.)	4.8	5.6	50.8	7.2	164.0 93.0	170.0 210.0
Carbon dioxide (dissolved) (p.p.m.)	3.1	4.2	25.0	14.0	3.8 5.5	8.3 13.0
Oxygen (dissolved) (p.p.m.)	9.30	9.20	5.20	8.80	6.30 7.84	8.00 13.00
Suspended Solids (p.p.m.)	8.3	2.6	27.2	2.9	5.3 2.6	6.8 7.1
Turbidity (p.p.m.)	11.9	15.8	48.	16.7	20.3 12.7	21.5 26.0
Temp. (C.°)	19.5	18.0	19.1	17.2	21.2 20.8	17.0 17.2
Total Cond. (× 10^{-4} mhos)	1.49	1.42	2.5	1.56	5.72 3.83	4.68 5.27

E MUDDY

	Summer	*Summer*	*Fall*	*Fall*	*Fall*	*Fall*
Stations	136	136	131	133	139	135
Hardness Total (p.p.m.)	81.20	60.00	53.60	154.00	70.00	80.00
Alkalinity (p.p.m.)	72.00	64.00	58.00	150.00	59.00	43.60
pH	7.7	7.6	7.6	8.3	7.4	8.2
Calcium (p.p.m.)	30.20	20.40	15.10	109.00	31.90	21.20
Magnesium (p.p.m.)	1.43	2.40	3.84	45.00	12.30	6.59
Nitrogen (N as NH_4^+) (p.p.m.)	0.009	0.030	0.085	1.750	0.101	0.070
Nitrogen (N as NO_2) (p.p.m.)	0.0500	0.0060	0.008	0.0140	0.072	0.0440
Nitrogen (N as NO_3) (p.p.m.)	0.300	0.240	0.507	0.650	0.520	0.253
Phosphorus (P as PO_4) (p.p.m.)	0.002	0.028	0.007	0.176	0.084	0.110
Iron (p.p.m.)	0.334	0.480	0.109	0.200	0.140	0.048
Silica (p.p.m.)	13.90	11.40	17.10	1.56	17.74	15.46
Chloride (p.p.m.)	4.6	2.0	3.0	18.0	4.2	4.0
Sulphate (p.p.m.)	102.0	10.8	6.4	275.6	17.6	16.8
Carbon dioxide (dissolved) (p.p.m.	2.9	3.4	2.4	....	4.8	$<$ 1.0
Oxygen (dissolved) (p.p.m.)	8.80	7.60	8.96	6.40	11.12	11.38
Suspended Solids (p.p.m.)	4.6	20.5	....	....	....	....
Turbidity (p.p.m.)	12.6	26.8	13.7	7.7	11.0	8.6
Temp. (C.°)	24.2	23.8	....	....	9.5	7.5
Total [illegible]d. (× 10^{-4} mhos)	3.56	1.94		....		....

MILL C

	Summe	*Summer*	*Summe*	*Summer*	*Summer*	*Summer*
[illegible]	88	89	87	85A, 85B [1]	84	82
Hardness Total (p.p.m.)	37.60	134.00	104.80	158.00 170.00	163.00	164.00
Alkalinity (p.p.m.)	38.80	106.90	87.80	127.00 127.00	131.00 135.00	148.00
pH	7.7	7.9	7.8	7.8 7.7	7.7 7.8	7.7
Calcium (p.p.m.)	10.60	25.60	19.80	34.70 36.60	36.40 25.60	34.90
Magnesium (p.p.m.)	2.70	17.05	13.50	17.50 19.10	17.50 9.10	18.40
Nitrogen (N as NH_4^+) (p.p.m.)	0.116	0.02	0.165	0.148 0.312	0.020 0.173	0.086
Nitrogen (N as NO_2) (p.p.m.)	0.00	0.01	0.008	0.022 0.040	0.030 0.037	0.0150
Nitrogen (N as NO_3) (p.p.m.)	0.06	0.02	0.780	3.500 3.200	3.600 0.200	0.920
Phosphorus (P as PO_4) (p.p.m.)	0.02	0.06	0.208	0.050 0.103	0.055 0.020	0.055
Iron (p.p.m.)	0.09	0.04	0.085	0.500 0.200	0.610 0.800	0.010
Silica (p.p.m.)	6.90	5.73	6.60	6.70 6.40	6.58 5.57	6.28
Chloride (p.p.m.)	4.4	6.3	3.6	4.0 3.6	4.2 4.6	5.6
Sulphate (p.p.m.)	6.0	6.4	8.0	12.8 12.0	10.0 8.0	8.4
Carbon dioxide (dissolved) (p.p.m.)	1.4	2.5	3.0	3.8 4.9	5.0 4.1	5.9
Oxygen (dissolved) (p.p.m.)	8.90	11.20	9.76	9.10 8.70	9.00 6.80	8.24
Turbidity (p.p.m.)	15.3	15.3	15.3	14.3 6.1	18.4 53.8	32.0
Temp. (C.°)	19.8	20.1	19.3	19.8 23.5	20.8 28.0	21.2
Total Cond. ($\times 10^{-4}$ mhos)						

	.L CRI EK			LIT RUN SERIES		
	Summer	*ummer*	*Summ*	*July*	*July*	*July*
Stations	80	79	70	96	105	106
Hardness Total (p.p.m.)	181.60	105.60	188.00	184.00	178.00	165.00
Alkalinity (p.p.m.)	168.00	175.00	180.60	185.50	188.00	202.00
pH	7.6	8.0	7.7	7.2	7.2	7.8
Calcium (p.p.m.)	39.70	36.10	36.00	58.30	62.90	63.00
Magnesium (p.p.m., ...	20.00	3.70	23.70	7.85	4.69	1.87
Nitro . (N as NH_4^+) (p.p.m.)	0.066	0.380	0.145	0.047	0.258	0.360
Nitro . (N as NO_2) p.p.m.) .	0.0250	0.0300	0.030	0.0050	0.0140	0.0250
Nitro . (N as NO_3) p.p.m.) ..	1.780	1.330	1.490	0.317	6.230	0.707
Phos rus (P as PO_4] (p.p.m.)	0.025	0.036	0.038	0.010	0.008	0.017
Iron (p.p.m.)	0.096	0.040	0.170	0.155	0.126	0.152
Silica (p.p.m.)	5.67	6.37	6.20	7.63	8.10	8.77
Chloride (p.p.m.)	6.6	4.4	6.0	4.2	2.0	6.0
Sulphate (p.p.m.)	8.0	10.0	9.2	8.8	...	11.6
rbon dioxide (d solved] p.p	8.9	3.7	6.7	24.0	24.0	6.7
ygen (dissolved] (p.p.m	7.20	10.80	7.60	7.60	8.00	8.80
spended Solids .p.m	...	...	...	...	21.0	4.0
rbidity (p.p.m	48.5	71.0	33.8	0.0	3.5	0.0
mp. (C.°)	21.0	19.0	22.8	11.7	11.9	13.0
tal Cond. (mh	...	...	...	...	...	5.15

LITITZ RUN SER

	July	July	July	July	July	July
Stations	107	108	111	110A	104	122
Hardness Total (p.p.m.)	8.00	165.00	190.00	67.00	154.00	186.00
Alkalinity (p.p.m.)	4.00	202.00	189.00	91.00	171.00	184.00
pH	7.8	7.8	7.4	7.4	7.8	7.8
Calcium (p.p.m.)	6.00	64.90	66.70	58.90	60.60	64.80
Magnesium (p.p.m.)	0.87	0.78	5.70	5.00	0.68	5.80
Nitrogen (N as NH_4^+) (p.p.m.)	0.730	0.550	0.290	0.136	0.138	0.015
Nitrogen (N as NO_2) p.p.m.)	0.025	0.0370	0.050	0.048	0.056	0.0540
Nitrogen (N as NO_3) p.p.m.)	3.590	0.277	2.660	1.955	1.485	0.247
Phosphorus (P as PO_4 (p.p.m.)	0.004	0.004	0.001	0.004	0.001	$<$ 0.001
Iron (p.p.m.)	0.227	0.110	0.150	0.125	0.056	0.585
Silica (p.p.m.)	8.77	8.77	8.40	8.10	8.04	7.60
Chloride (p.p.m.)	6.0	6.2	7.0	6.4	6.0	4.8
Sulphate (p.p.m.)	11.2	2.8	8.4	10.8	8.8	7.2
Carbon dioxide (dissolved) (p.p.m	6.0	6.6	15.0	15.0	5.6	5.9
Oxygen (dissolved) (p.p.m.)	8.80	8.40	8.30	9.50	9.50	9.76
Suspended Solids (p.p.m.)	6.7	4.1	243.0	10.0	24.0	40.0
Turbidity (p.p.m.)	0.0	6.0	4.5	6.0	20.0	23.7
Temp. (C.°)	3.0	3.0	13.5	14.3	18.2	15.8
Total Cond. mh	5.28	5.28		...	...	4.20

[TZ RU SER

	Augus	*August*	*August*			*Augus*
Static	96	105	106	107	108	111
Iardı Total (p.p.m	194.00	206.00	208.00	190.00	208.00	184.00
lkali (p.p.m.)	189.60	190.00	202.00	204.00	201.00	201.00
pH	7.2	7.3	7.4	7.4	7.3	7.3
Calcium (p.p.m.)	69.70	74.80	79.00	74.00	79.00	72.00
Magnesium (p.p.m.)	4.90	4.80	2.43	1.21	2.30	1.14
Nitro n (N as NH_4^+ p.p.m.)	0.036	0.015	0.060	0.198	0.124	0.06
Nitro n (N as NO_2) p.m.)	0.000	0.0260	1.0700	0.1050	0.90	0.06
Nitro n (N as NO_3) p.m.)	4.420	3.120	2.780	3.150	4.39	4.52
Ph orus (P as PO (p.p.m.)	0.002	1.000	0.047	0.043	0.08	0.05
Iron (p.p.m.)	0.244	0.187	0.352	0.298	0.26	0.09
Silica (p.p.m.)	8.13	9.20	8.40	9.14	8.80	8.80
Chloride (p.p.m.)	3.6	3.4	7.8	7.4	7.0	6.4
Sulphate (p.p.m.)	14.0	12.8	21.2	16.8	18.0	18.0
Carbon dioxide (d solved) (p.p.m	24.0	19.0	17.0	17.0	21.0	21.0
Oxygen (dissolved) (p.p.m.)	8.00	8.00	7.50	7.50	7.04	6.50
Suspended Solids p.p.m.)	90.0	1.3	23.3	41.0	41.0	8.7
Turbidity (p.p.m.	0.0	10.8	96.8	76.6	62.0	24.0
Temp. (C.°)	11.2	14.0	15.5	17.8	15.8	14.5
Total C nd. (× 0^{-4} m s)	4.29	4.29	4.72	4.70	4.78	4.78

TITZ RUN SERIES

	Augus	August	August	Fall	Fall	Fall
	110A	104	122	96	105	106
dness Total (p.p.m.)	220.00	172.00	196.00	87.60	95.20	38.00
Alkalinity (p.p.m.)	201.00	186.00	207.00	85.00	96.20	08.00
pH	7.2	7.7	7.7	7.4	7.6	7.6
Calcium (p.p.m.)	81.30	68.00	69.70	58.70	69.90	83.70
Magnesium (p.p.m.)	4.10	0.60	5.30	9.87	5.17	7.05
Nitrogen (N as NH_4^+) (p.p.m.)	0.05	0.360	0.007	0.055	0.039	0.20
Nitrogen (N as NO_2) (p.p.m.)	0.05	0.0790	0.066	0.000	0.0291	0.16
Nitrogen (N as NO_3) (p.p.m.)	2.99	5.460	5.540	5.620	4.720	1.71
Phosphorus (P as PO_4) (p.p.m.)	0.18	0.000	0.013	0.004	0.076	0.36
Iron (p.p.m.)	0.09	0.513	0.171	0.100	0.005	0.05
Silica (p.p.m.)	8.86	7.43	7.77	9.18	9.38	14.15
Chloride (p.p.m.)	7.6	6.4	8.0	3.0	3.4	63.8
Sulphate (p.p.m.)	20.0	16.0	15.2	8.0	10.0	16.8
Carbon dioxide (dissolved) (p.p.m.)	27.0	7.7	8.4	15.0	10.0	11.0
Oxygen (dissolved) (p.p.m.)	7.20	9.40	9.50	7.84	7.36	4.72
Suspended Solids (p.p.m.)	5.8	24.9	5.3	....	....	....
Turbidity (p.p.m.)	6.5	26.0	15.1	0.0	11.4	42.0
Temp. (C.°)	13.8	15.5	15.2	11.0	16.0	17.0
Total Cond. ($\times 10^{-4}$ mhos)	4.57	4.47	4.47	...	...	...

	RUN SE			LIT	
	Fall	*Fall*	*Fall*	*July*	*July*
Stations	108	110	122	99	109
Hardness Total (p.p.m.)	95.20	214.40	216.00	52.00	74.00
Alkalinity (p.p.m.)	97.80	213.00	190.00	48.00	78.00
pH	7.4	7.7	7.8	7.6	7.4
Calcium (p.p.m.)	73.00	69.30	72.20	48.80	63.00
Magnesium (p.p.m.)	3.10	10.10	8.65	7.48	3.50
Nitrogen (N as NH_4^+) (p.p.m.) ..	0.895	0.596	0.025	0.329	0.427
Nitrogen (N as NO_2) (p.p.m.)	0.1556	0.0727	0.0596	0.0550	0.0380
Nitrogen (N as NO_3) (p.p.m.)	1.376	1.087	2.570	0.246	0.275
Phosphorus (P as PO_4) (p.p.m.) ..	0.206	0.136	0.000	0.008	0.000
Iron (p.p.m.)	0.074	0.050	0.143	0.150	0.110
Silica (p.p.m.)	10.48	8.50	9.04	8.95	8.13
Chloride (p.p.m.)	25.8	12.0	10.0	6.4	7.0
Sulphate (p.p.m.)	19.2	20.4	11.6	8.4	14.0
Carbon dioxide (dissolved) (p.p.m.	15.0	7.6	6.0	8.2	14.0
Oxygen (dissolved) (p.p.m.)	5.20	4.96	10.40	9.00	9.70
Suspended Solids (p.p.m.)	....	....	....	$<$ 0.1	17.0
Turbidity (p.p.m.)	80.4	13.5	9.1	5.0	1.9
Temp. (C.°)	18.0	....	14.5	14.2	23.2
Total Cond. (× 10^{-4} mhos)				....	5.03

APPENDIX 3

SPECIES LIST OF BACTERIA *

By D. G. REIHARD, JR.
Pennsylvania State College

Achromobacter butyri. Station nos. 9, **13**, *16*, 28, 70, *104*, 105, 106, 108, 110, 116, *122*, 126, 127, *128*, *129*, 131, 133, *135*, 136, 139a, *139*, 142, 146, 147, 152, 154, 155, 158, 160.

Achromobacter cycloclastes. Station nos. 1, *13*, **13**, 28, 70, 84a, 85a, 85d, 87, 96, 104, *104*, 105, *105*, 106, 107, 108, 110, **110a**, 121, **122**, *126*, 128, *128*, *129*, 131, *131*, *133*, 136, 137, 139a, 147, 155.

Achromobacter delicatulum. Station nos. 1, 5, 9, *13*, **13**, *16*, 28, *28*, 63, 70, 96, **96**, 99, **105**, **106**, 107, 109, 110, 121, *122*, 126, *126*, 127, 128, *128*, *129*, *131*, *133*, 136, *139*, 147, 152, 154, 155, 158, 160, 169.

Achromobacter delmarvae. Station nos. **13**, 16, 28, *28*, 85d, 85e, 99, 105, *105*, 106, 110, **122**, *126*, *128*, *129*, 131, *133*, 136, 139b, 142, 147, 152, 154.

Achromobacter eurydice. Station nos. 1, 5, 9, *13*, **13**, *20*, 28, *28*, 70, 85a, 87, 96, 99, 104, 105, *105*, **105**, 106, **106**, 107, **108**, 110, **110a**, *122*, **122**, *126*, 127, 128, *128*, *129*, 131, *131*, 133, *133*, 136, 137, 139b, *139*, 141, 146, 158, 169.

Achromobacter isophagum. Station nos. 87, 108, 147, 152.

Achromobacter liquefaciens. Station nos. 28, 87, **96**, 106, **110a**, 126, *133*, *135*, 139a, 142, 146, 158.

Achromobacter superficialis. Station nos. *16*, 28, 70, 84a, 85d, 85e, 87, 99, 104, *104*, **105**, **106**, 108, 109, *122*, 126, *128*, *131*, *135*, 141, 155.

Alcaligenes bookeri. Station nos. *13*, 28, 96, 139b, 142, 154.

Alcaligenes faecalis. Station nos. 1, **13**, *20*, 28, 70, 84a, 85d, 85e, 87, 104, *104*, 105, *105*, 106, 107, 108, 109, 121, 128, *129*, 131, *131*, 133, 137, *139*, 141, 155, 160.

Alcaligenes marshalii. Station nos. *28*, 85a, 85e, 99, *104*, *105*, 126, *126*, 133, 136, 137, 139a, 139b, 141, 142, 155, 158, 160.

Alcaligenes metalcaligenes. Station nos. 5, *13*, **13**, 28, 96, **96**, *104*, *105*, 106, 108, 110, 121, **122**, 126, *126*, *128*, 133, *133*, *135*, 136, 139b, *139*, 141, 142, 152, 154, 155, 160.

Alcaligenes recti. Station nos. *13*, **13**, *104*, 110, *122*, *135*, 139a, 146, 147, 158.

Alcaligenes viscosus. Station nos. 96, 99, *129*, 139b, 147, 152.

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* The italic and bold face station numbers should be interpreted as follows: number in light face Arabic is the first time of sampling; number in italics, second survey; number in bold face, third survey.

Bacillus sp. Station nos. 5, *13*, *16*, *20*, 28, *28*, 63, 70, 85a, 96, **96**, 104, *104*, *105*, **105**, 106, **106**, 108, **108**, 110, 121, *122*, **122**, *128*, *129*, *131*, *133*, *135*, 136, 139b, *139*, 141, 142, 147, 152, 155, 158, 160, 169.

Chromobacterium amethysteum. Station no. 87.

Chromobacterium ianthinum. Station no. 107.

Chromobacterium sp. Station nos. 1, 99, 104, 105, 109, 121, 131, 139b, 147.

Coliform. Station nos. **18**, 28, *28*, 70, *105*, **106**, 107, **108**, **110a**, *131*, *135*, *139*, 152, 158.

Corynebacterium sp. Station no. 141.

Flavobacterium aquatilis. Station nos. *13*, 70, 87, 96, 116, *126*, 133, 137, 141, 146, 147, 152, 154, 155, 158.

Flavobacterium arborescens. Station nos. 104, *104*, 107, *135*, 136, 137, 139a, *139*, 141, 146, 147, 152, 158.

Flavobacterium brevis. Station nos. *13*, 70, 85d, 99, 104, 105, 106, 141.

Flavobacterium devorans. Station nos. 70, 87, **105**, 106, 131, 154, 160.

Flavobacterium diffusum. Station nos. 28, 104.

Flavobacterium dormitator. Station nos. 28, *28*, 70, 84a, *126*, *128*, *129*, 133, *135*, 137, 139a, 146.

Flavobacterium esteroaromaticum. Station nos. 9, **18**, 28, *28*, 84a, 85d, 87, 107, **108**, 116, *126*, 131, *131*, 141, 147.

Flavobacterium ferrigineum. Station nos. *16*, **105**, **108**, **122**, 137, 139b, 146, 152, 155.

Flavobacterium flavotenue. Station nos. *16*, *28*, 85e, 87, *104*, 105, 116, 131, 133, *135*, 139a, 141, 142.

Flavobacterium fucatum. Station nos. *13*, 87, 146.

Flavobacterium harrisonii. Station nos. 28, 127.

Flavobacterium invisibilis. Station nos. 1, *13*, *20*, *28*, 84a, 87, 99, *104*, 105, 107, 109, **110a**, *122*, **122**, *126*, *128*, *129*, 139a, 139b, 147, 154, 158.

Flavobacterium lactis. Station nos. 1, 28, 70, 84a, 85d, 85e, 87, 106, 107, 108, 131, 139a, 147, 152.

Flavobacterium lutescens. Station nos. **18**, 70, *105*, 146.

Flavobacterium marinum. Station nos. *13*, 28, 85a, 85d, 87, 107, *122*, 137, 147, 160.

Flavobacterium proteus. Station nos. **18**, 139b.

Flavobacterium rigensis. Station nos. 1, *13*, *16*, 28, 70, *105*, 139a.

Flavobacterium rhenanus. Station nos. *13*, *16*, *28*, 127.

Flavobacterium solare. Station nos. 1, 5, 9, *13*, **18**, *28*, 70, 84a, 96, *105*, 107, 108, **108**, 116, 121, **122**, 126, *126*, 127, 128, *129*, 131, *135*, 139a, *139*, 142, 154, 160, 169.

Flavobacterium suaveolens. Station nos. *16*, 87, 116, *122*, 126, 142.

Flavobacterium sp. Station no. 109.

Micrococcus sp. Station nos. *20*, **105**, **108**, *129*, *135*, *139*.

Proteus morganii. Station no. 85a.

Pseudomonas sp. (non-pigmented). Station nos. 5, *13*, *16*, 28, 63, 70, 85d, 85e, 87, **96**, 99, 104, *104*, 105, 106, **106**, 108, 109, **110a**, 121, *122*, **122**, 128, 131, *131*, *133*, *135*, 139b, *139*, 142, 152, 155.

Pseudomonas sp. (yellow). Station no. 121.

Sarcina. Station nos. *20*, **106**, **108**, **122**, *129*, *135*.

Serratia sp. Station nos. 1, 5, *16*, *28*, 87, 101, *104*, 106, 107, 108, 116, 126, *126*, 131, 136, 139a, 141, 158.

Serratia sp. (non gel. liq.). Station no. 126.

Streptomyces sp. Station nos. 5, 9, *13*, *20*, *28*, 63, **96**, 99, 101, 104, 105, **105**, **106**, 108, 116, *122*, *129*, *131*, *135*, 139a, 141, 142, 169.

APPENDIX 4

CHARTS OF STATIONS SURVEYED

Hammer Creek

STATION 152.—Buffalo Springs, Heidelberg Township, Lebanon County. Elevation 480-500 ft. Average width 14 ft. Average depth 8 inches. Bedrock limestone. Shores artificial rock walls. Large cold spring containing many stocked trout. Total bacterial count 25 per ml. Coliform count 5 per ml. This station is atypical due to cool temperature and artificial ecological conditions. B.O.D. 1.5 p.p.m.

STATION 153.—One and a half miles down stream from Buffalo Springs, Heidelberg Township, Lebanon County. Elevation 460-480 ft. Average width 9 ft. 10 inches. Average depth 11 inches. Bedrock limestone. Shore pasture. Stream bottom gravel, sand, and boulder. Organic enrichment evident by common occurrence of *Nitzschia palea* and *Dileptus monilatus*. B.O.D. 7.2 p.p.m.

STATION 116.—Three miles below Buffalo Springs, Heidelberg Township, Lebanon County. Elevation 460 ft. Average width 15 ft. Average depth 8.5 inches. Shores pastures, banks cut, bedrock shale. Stream bed rubble, some mud bars, rocks. Fish low due to obstruction caused by large fallen tree. Total bacterial count 4,200 per ml. Coliform count 540 per ml. B.O.D. 1.5 p.p.m.

STATION 147.—One and a quarter miles east-northeast of Penn; 2 miles southwest of Brickerville, Elizabeth Township, Lancaster County. Elevation 380-400 ft. Average width 30 ft. Average depth 11.7 inches. Bedrock shale. Shore pastures, banks fairly well cut. Total bacterial count 500 per ml. Coliform count 63 per ml. B.O.D. 2 p.p.m.

STATION 146.—One mile northeast of Brunnerville, Clay-Elizabeth Township, Lancaster County. Elevation 360 ft. Average width 28 ft. Average depth 15 inches. Shore pastures. Bedrock shale. Stream bed gravel, sand, and some mud. Bacterial count 17,100 per ml. B.O.D. 5 p.p.m. Organic enrichment is indicated but it is not of sufficient quantity to upset the biodynamic cycle.

STATION 28.—One-half mile north of Millway, Ephrata Township, Lancaster County. Elevation 320 ft. Average width 27 ft. Average depth 10 inches. Shores pasture land. Bedrock limestone. Bed of stream gravel, near banks mud. Organic enrichment indicated by common occurrence of ***Spirogyra, Phormidium autumnale, Melosira varians***, and abundance of ***Cephalodella gibba***. Total bacterial count 2,800 per ml.

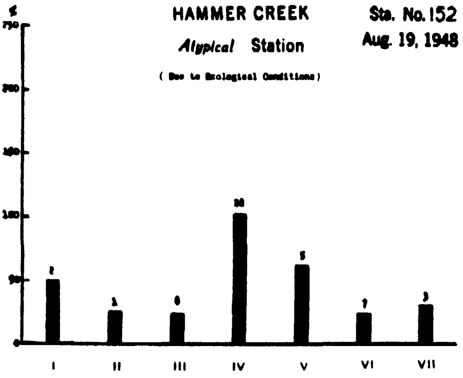

Fig. 1

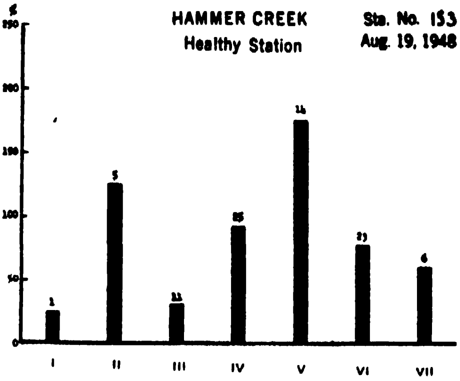

Fig. 2

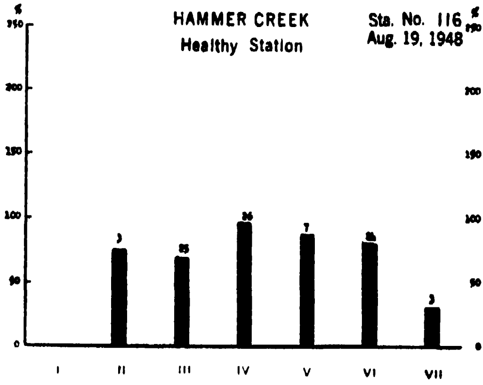

Fig. 3

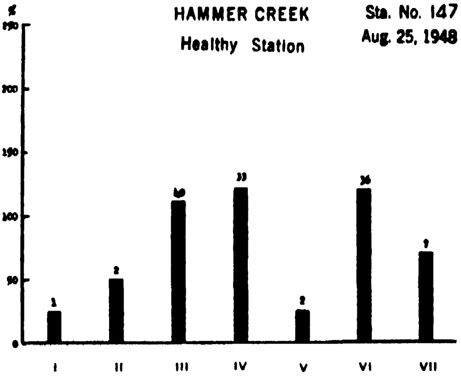

Fig. 4

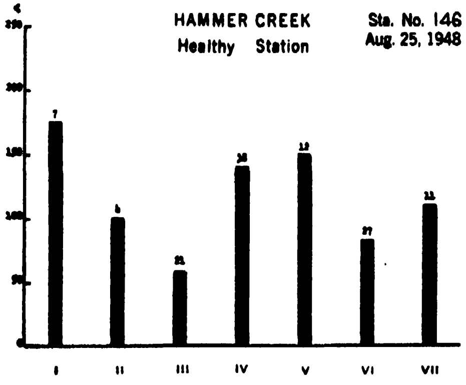

Fig. 5

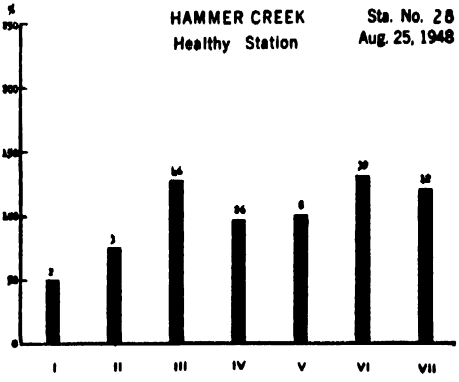

Fig. 6

Explanations on facing page

Cocalico Creek

STATION 156.—Three and one-half miles west of Reinholds and 1.5 miles southeast of Cocalico, West Cocalico Township, Lancaster County. Elevation 440 ft. Average width 11 ft. Average depth 6.3 inches. Shores pasture, banks cut. Bedrock shale. Bed of stream mostly gravel, some mud. Indication of organic enrichment by common occurrence of *Nitzschia palea.* B.O.D. 2 p.p.m.

STATION 154.—Two miles northwest of Denver, 1.5 miles west of Reinholds, West Cocalico Township, Lancaster County. Elevation 410 ft. Average width 18 ft. Average depth 7 inches. Woodland, just below a dam. Bedrock quartz conglomerate. Stream bed mud, gravel, and rocks. Common occurrence of blue-green algae, *Nitzschia palea,* and certain rotifers and protozoa indicated organic enrichment. Total bacterial count 62,000 per ml. Coliform count 8 per ml. B.O.D. 2.1 p.p.m.

STATION 155.—One-quarter mile west of Denver, West Cocalico Township, Lancaster County. Elevation 400 ft. Average width 29 ft. Average depth 7.3 inches. Shores grassy woodland. Bedrock shale and sandstone. Stream bed shale and sandstone gravel, boulders, and some mud. Total bacterial count 810 per ml. B.O.D. 2.1 p.p.m.

STATION 158.—Three-quarters of a mile southwest of Reamstown, East Cocalico Township, Lancaster County. Elevation 360–380 ft. Average width 68 ft. 6 inches. Average depth 18 inches. Banks grassy. Bedrock limestone. Stream bed gravel and rubble, mud near edge. Organic enrichment is indicated by fair abundance of *Spirogyra* and *Nitzschia palea.* Total bacterial count 1,290 per ml. B.O.D. 2 p.p.m. Coliform count 45 per ml.

STATION 160.—One mile northwest of Akron, Ephrata Township, Lancaster County. Elevation 320 ft. Average width 41 ft. Average depth 1 ft. 1 inch. Shore grassy woodland. Bedrock limestone. Stream bed mud, gravel, rubble, and boulders. Total bacterial count 5,900 per ml. Coliform count 34 per ml.

Little Muddy Creek

Summer Survey

STATION 138.—One and three-quarters miles north of Adamstown, Brecknock Township, Berks County. Elevation 500 ft. Average width 9 ft. Average depth 5 inches. Banks steep. Bedrock quartz conglomerate. Stream bed sand, gravel, rock, and boulders. The frequent occurrence of *Nitzschia palea, Philodina citrina* and chironomids indicated organic enrichment. B.O.D. 2.8 p.p.m.

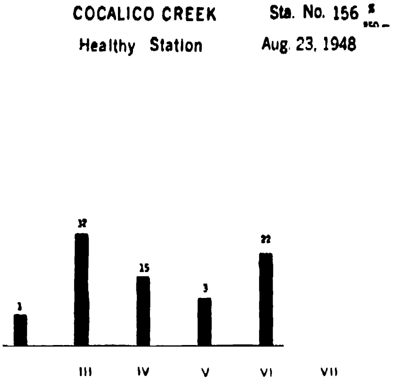

Fig. 7

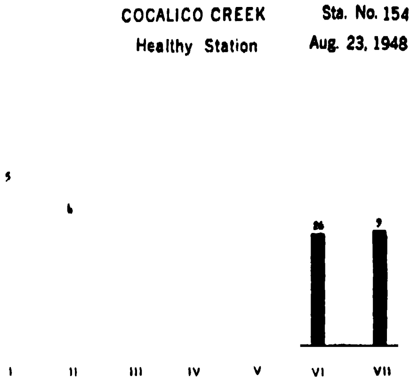

Fig. 8

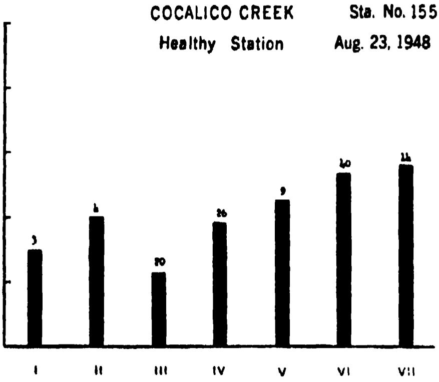

Fig. 9

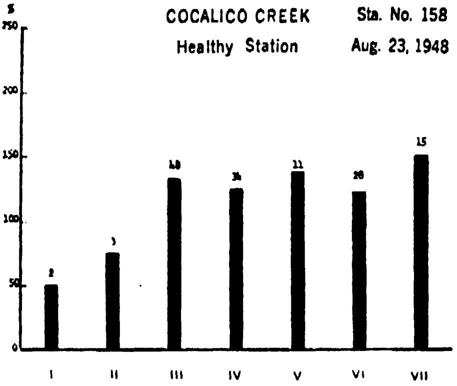

Fig. 10

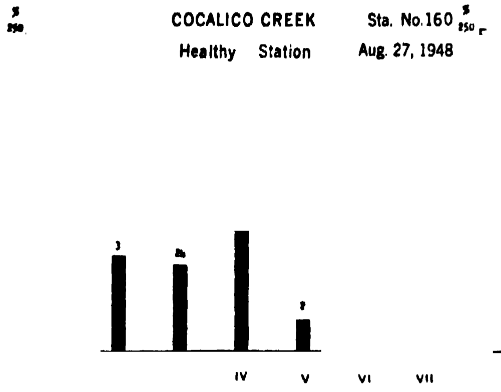

Fig. 11

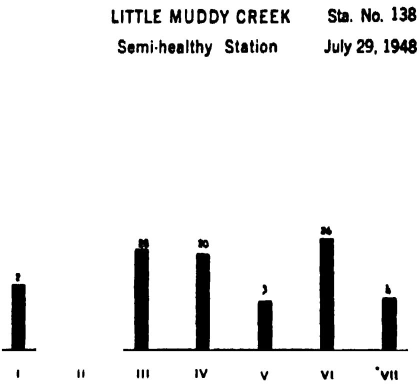

Fig. 12

Explanations on facing page

Little Muddy Creek

Summer Survey

(continued)

STATION 131.—Southern edge of Adamstown, Brecknock Township, Lancaster County. Elevation 480 ft. Average width 19 ft. Average depth 7.5 inches. Banks grassy, some shrubs and trees. Bedrock sandstone. Stream bed sand and gravel with mud at edges. Indicators of organic enrichment were the protozoa, *Dileptus monilatus*, and *Nassula aurea;* the algae, *Phormidium autumnale, Oscillatoria formosa, Oscillatoria chalybea,* and *Nitzschia palea.* Total bacterial count 35,000 per ml. B.O.D. 2.9 p.p.m. Coliform count 50 per ml.

STATION 132.—Small trenched tributary 50 ft. below Station 131, carrying effluent of Bollman Hat Factory. Elevation 480 ft. Average width 2 ft. 6 inches. Average depth 3.5 inches. Banks trenched. Organic pollution indicated by *Eristalis* (the rat-tail maggot) and *Sphaerotilus.* B.O.D. 2.5 p.p.m.

STATION 133, A. & B.—Just below Station 132 on Little Muddy Creek. Average width 14 ft. Average depth 3.5 inches. Banks grassy. Bedrock sandstone. Stream bed rocks with rubble and gravel. Severe organic pollution indicated by great abundance of *Sphaerotilus.* Total bacterial count 1,200,000 per ml.

STATION 134.—One hundred fifty ft. below Station 133. Average width 18 ft. Average depth 6 inches. Right bank grassy. Left bank eroded, some weeds. Bedrock sandstone. Stream bed sand, gravel, rubble, and clay. Strong organic pollution indicated by abundance of *Sphaerotilus,* the rotifer, *Rotaria vulgaris,* chironomids, and the protozoan, *Hexamitus inflatus.* B.O.D. 2.8 p.p.m.

STATION 137.—Just above the hosiery mill at Adamstown .15 mile below Bollman Hat Factory. Average width 20 ft. Average depth 7 inches. Bedrock sandstone. Stream bottom sand and mud. Indicators of pollution, heavy leech population, very high bacterial count (170,000 per ml.), and abundance of protozoan, *Hexamitus inflatus.* Coliform count 650 per ml. B.O.D. 4-6 p.p.m.

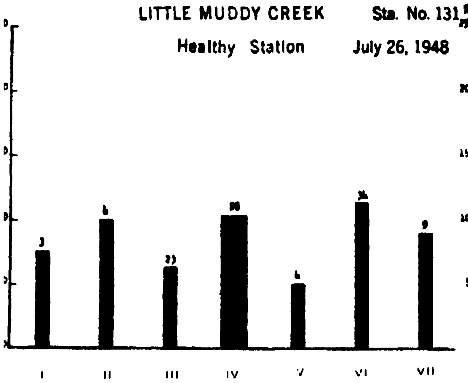

Fig. 13

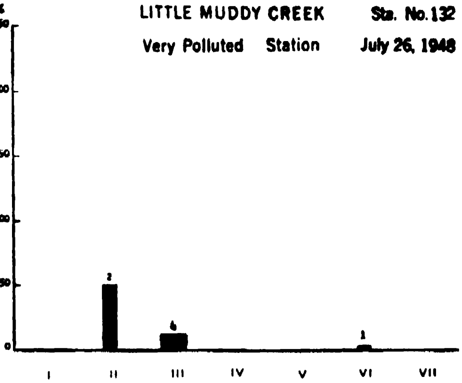

Fig. 14

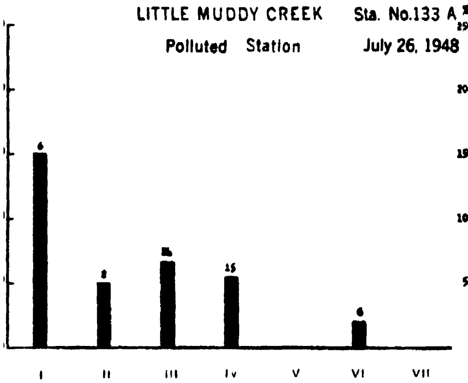

Fig. 15

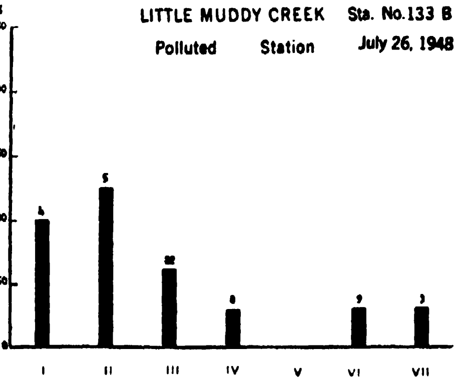

Fig. 16

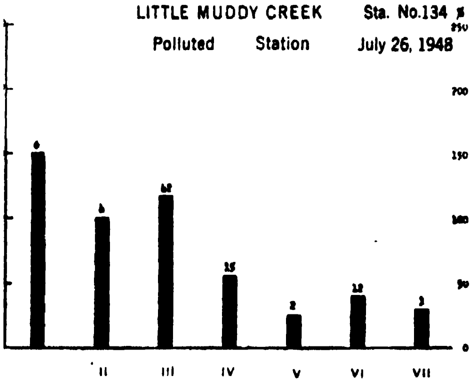

Fig. 17

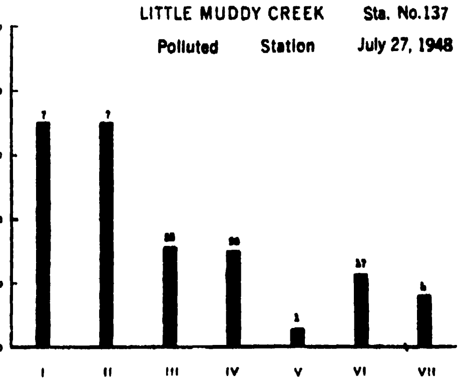

Fig. 18

Explanations on facing page

Little Muddy Creek

Summer Survey

(*continued*)

STATION **139-A**.—One hundred yards below Station 137. Right bank of stream opposite entrance of effluent from Adamstown Hat Factory. Average width 24 ft. Average depth 5.5 inches. Banks grassy. Bedrock sandstone. Stream bed sand and boulders. Indicators of pollution: abundance of *Limnodrilus*, leeches, chironomids, and the protozoa, *Hexamitus inflatus, Spirostomum ambiguum, Coleps hirtus*. Total bacterial count 29,000 per ml. Coliform count 83 per ml. B.O.D. 6.16 p.p.m.

STATION **139-B**.—Opposite Station 139-A, just below entrance of effluent of Adamstown Hat Factory. Average width 24 ft. Average depth 5.5 inches. Bank grassy. Stream bed sand, boulders, and mud near shore. Indicators of organic pollution: abundance of *Limnodrilus* and *Sphaerotilus*. Total bacterial count 20,200 per ml. Coliform count 410 per ml. B.O.D. 1.67 p.p.m.

STATION **136**.—One mile northwest of Chestnut School, Brecknock-Cocalico Township, Lancaster County. Average width 25 ft. Average depth 8 inches. Elevation 400 ft. Banks grassy. Bedrock shale. Stream bed mud, gravel, and rubble. Indicators of organic pollution: common occurrence of *Limnodrilus*, leeches, and chironomids. Bacterial count 8,100 per ml. Coliform count 28 per ml. B.O.D. 11.5 p.p.m.

STATION **135**.—One-quarter mile east of Red Run, Brecknock Township, Lancaster County. Elevation 360 ft. Average width at pool 45 ft., at riffles 21 ft. Average depth 4 ft. at pools, 5.5 inches at riffles. Banks grassy. Bedrock shaly sandstone. Stream bed sand, rubble, and mud. Water often very muddy owing to severe erosion just above this station. Total bacterial count 8,100 per ml. Coliform count 25 per ml. Flora and fauna reduced as compared to Station 136, no doubt owing to sporadic high silt load. B.O.D. 7 p.p.m.

Little Muddy Creek

Fall Survey

STATION *131*.[1]—Southern edge of Adamstown, Brecknock Township, Lancaster County. Elevation 480 ft. Average width 19 ft. Average depth 7.5 inches. Banks grassy, some shrubs and trees. Bedrock sandstone. Stream bed sand and gravel with mud at edges. The pattern is the same as the summer survey although the total number of species have shifted for some of the groups. The lack of sensitive rotifers is the greatest difference. Total bacterial count 28,150 per ml.

STATION *133*.—Just below Station 132 on Little Muddy Creek. Average width 14 ft. Average depth 3.5 inches. Banks grassy. Bedrock sandstone. Stream bed rocks with rubble and gravel. The two sides of the stream were not collected separately but brought together as one station. The total bacterial count 35,000 per ml. The pattern has shifted from polluted to semi-healthy. The bacterial count is down and the *Sphaerotilus* has diminished greatly in abundance.

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[1] Station numbers in italics, second survey; those in bold face, third survey.

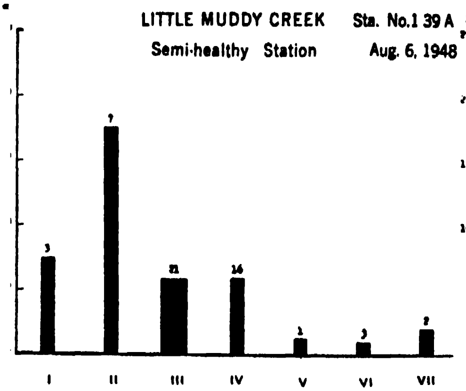

Fig. 19

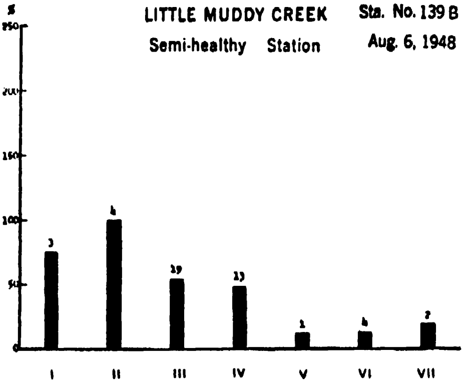

Fig. 20

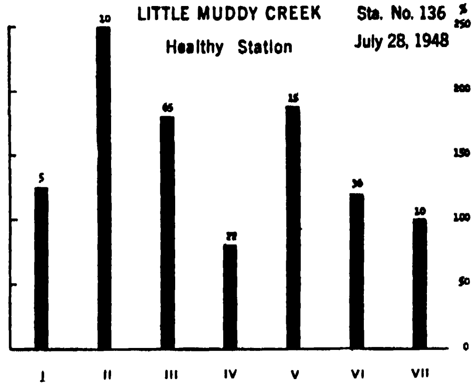

Fig. 21

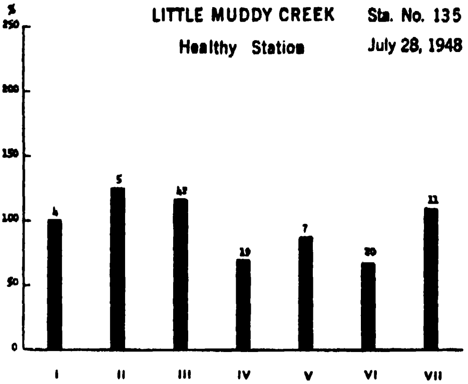

Fig. 22

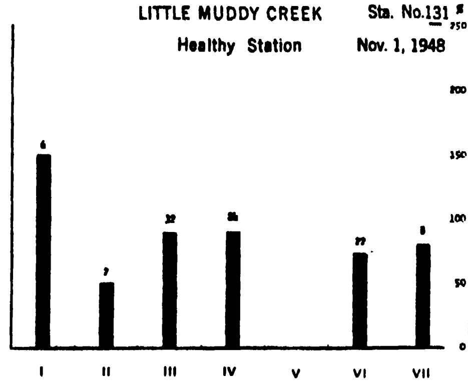

Fig. 23

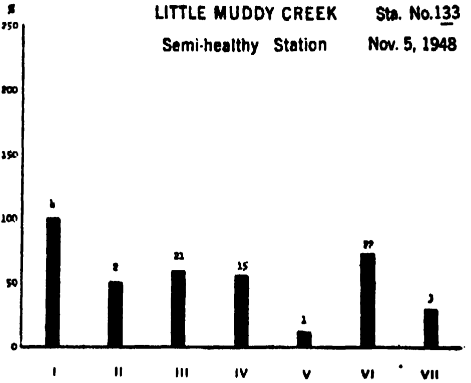

Fig. 24

Explanations on facing page

Little Muddy Creek

(*continued*)

STATION *139*-A.—One hundred yards below Station 137. Right bank of stream opposite entrance of effluent from Adamstown Hat Factory. Average width 24 ft. Average depth 5.5 inches. Banks grassy. Bedrock sandstone. Stream bed sand and boulders. The pattern has shifted from semi-healthy to polluted. This is evidenced by the absence of fish and the reduction in diatom species. The total bacterial count is higher, 56,000 per ml. The shift is not as great as it might seem at first as these two stages grade into each other.

STATION *139*-B.—Opposite Station 139-A, just below entrance of effluent of Adamstown Hat Factory. Average width 24 ft. Average depth 5.5 inches. Bank grassy. Stream bed sand, boulders and mud near shore. The pattern has shifted to " very polluted." This is evidenced by the reduced number of species in the various groups. The bacterial count is up somewhat, 56,000 per ml. The nitrate content is somewhat higher, but the sulphates are down. The chemical analysis would not indicate such a great change.

STATION *135*.—One quarter mile east of Red Run, Brecknock Township, Lancaster County. Elevation 360 ft. Average width at pool 45 ft., at riffles 21 ft. Average depth 4 ft. at pools, 5.5 inches at riffles. Banks grassy. Bedrock shaly sandstone. Stream bed sand, rubble, and mud. Water often very muddy owing to severe erosion just above this station. The pattern is similar to the one of the summer sampling except that the sensitive rotifers are lacking.

Mill Creek

STATION 88.—Three miles south of New Holland, Earl Township, Lancaster County. Elevation 420–440 ft. Average width 6 ft. 6 inches. Average depth 18 inches. Banks, pasture, somewhat cut. This station near headwater which is in metamorphosed rock, therefore has soft water, though bedrock is dolomite. Stream bed rubble and silt. Underground springs present.

STATION 89.—On the main highway three quarters mile south-southeast of New Holland, Earl Township, Lancaster County. Elevation 420–440 ft. Average width 9 ft. 3 inches. Average depth 10 inches. Bedrock dolomite. Stream bed rubble, clay, and gravel. Banks grassy. Organic pollution indicated by common occurrence of *Limnodrilus* and *Tubifex* worms, leeches, and chironomids.

STATION 87.—Two miles south of New Holland, Earl Township, Lancaster County. One tenth mile below entrance of New Holland's treated sewage waste. Elevation 420 ft. Average width 12 ft. 6 inches. Average depth 2 ft. Banks, pasture. Bedrock dolomite. Stream bed, rubble, sand, and some mud. Organic enrichment indicated by abundance of tolerant worms and mollusks, and the common occurrence of the algae, *Stigeoclonium nanum*. Total bacterial count 500–1500 per ml. Coliform count 38 per ml.

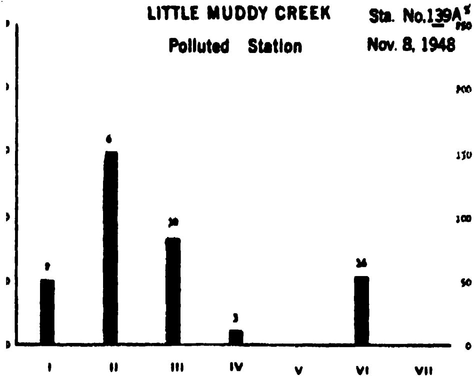

Fig. 25

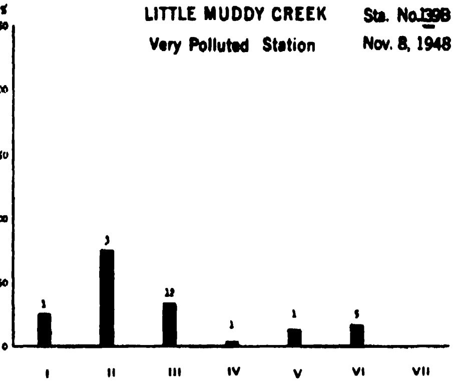

Fig. 26

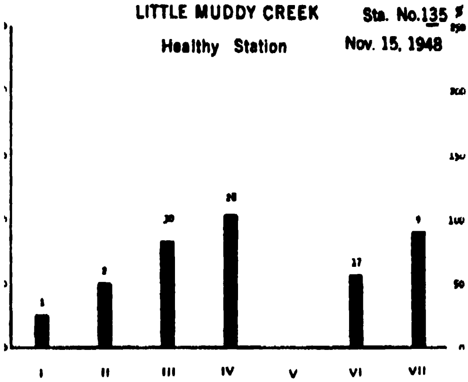

Fig. 27

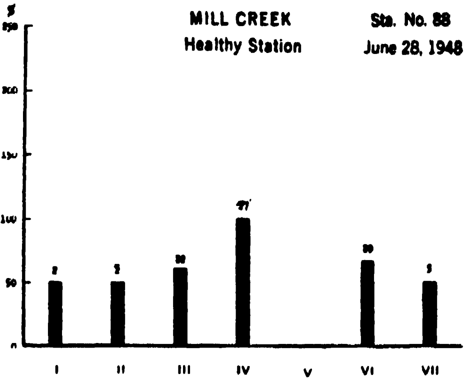

Fig. 28

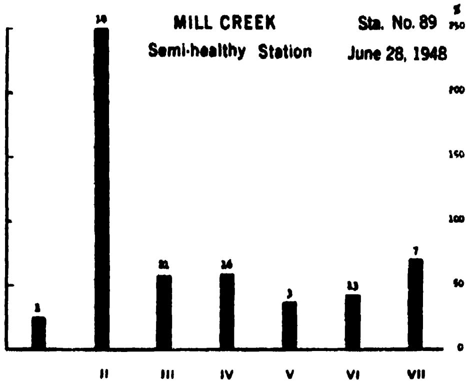

Fig. 29

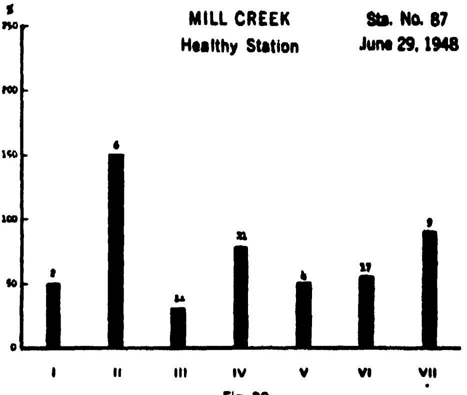

Fig. 30

Explanations on facing page

Mill Creek

(continued)

STATION 85-A.—Two miles north of Intercourse, Upper Leacock Township, Lancaster County. Elevation 380 ft. Average width 30 ft. Average depth 20 inches. Shores, pasture. Bedrock dolomite. Stream bed boulders and rubble. Indicators of organic enrichment were numerous leeches and tubificid worms and common occurrence of *Stigeoclonium tenue*. Total bacterial count 2,200. Coliform count 32 per ml.

STATION 85-B.—Opposite Station 85-A, spillway receiving effluent of cheese factory. Average width 22 ft. Average depth 8 inches. Banks grassy. Stream bed rubble and silt. Severe organic pollution indicated by great numbers of *Limnodrilus* and other tubificid worms, and the algae, *Spirogyra* and *Oscillatoria*. Total bacterial count 123,000 per ml. Coliform count 500 per ml.

STATION 85-C.—Seventy-five feet below confluence of Stations 85-A and B. Banks grassy, cut. Stream bed sand, mud, and rubble. Indicators of organic pollution: common occurrence of *Spirogyra* and *Limnodrilus*, and unbalanced insect fauna.

STATION 84-A.—One-half mile north of Centerville School, Earl Township, Lancaster County. Elevation 380 ft. Average width 26 ft. Average depth 30 inches. Banks pasture. Bedrock, limestone. Stream bed mud with a few rocks. Indicator of upset condition is the overabundance of algae in relation to other groups. Total bacterial count 5,100 per ml. Coliform count 31 per ml.

STATION 82.—At Mascot Bridge, West Earl Township, Lancaster County. Elevation 360 ft. Bedrock dolomite. Stream bed behind dam, mud; at face of dam, rock and silt; riffle, coarse rubble; bottom of pool, silt and rubble. This was a very large station composed of back water, and the overflow of a dam. This is a heavily enriched, healthy condition which approaches a semi-healthy state.

STATION 80.—One mile north of Smoketown, one-half mile north of Gibbon School, Upper Leacock Township, Lancaster County. Elevation 320–340 ft. Average width 125 ft. Average depth 31 inches. Banks grassy with rushes interspersed. Bedrock dolomite. Stream bed mud. Organic enrichment is indicated by abundance of *Spirogyra* and frequent occurrence of chironomids and *Limnodrilus*.

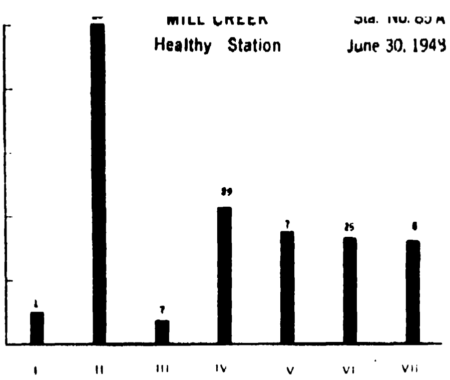

Fig. 31

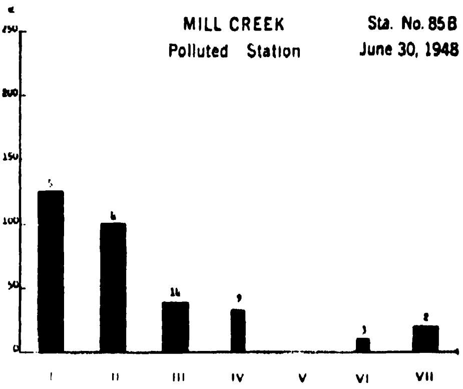

Fig. 32

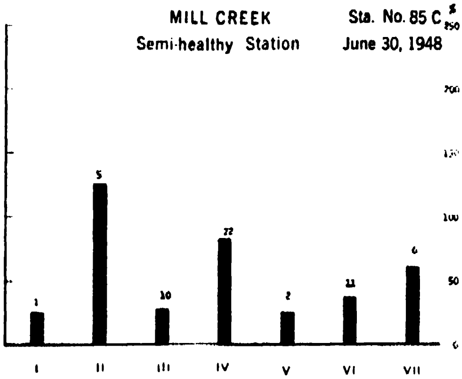

Fig. 33

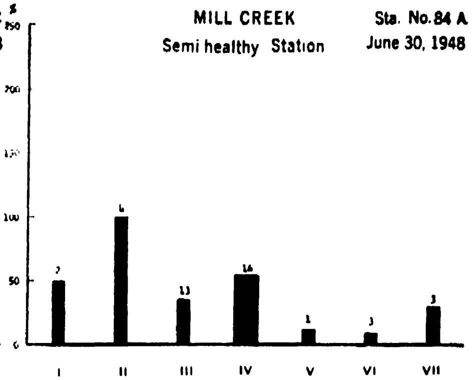

Fig. 34

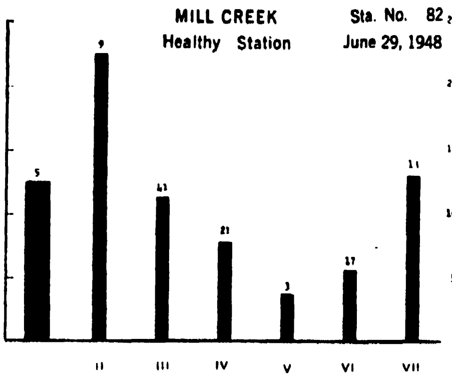

Fig. 35

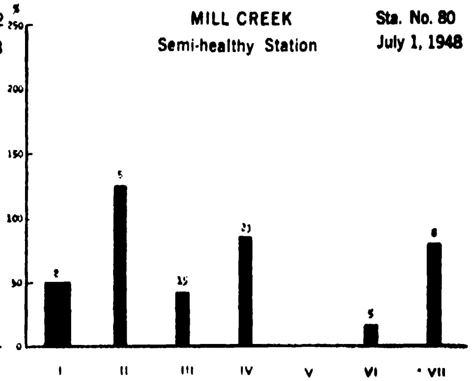

Fig. 36

Explanations on facing page

Mill Creek

(*continued*)

STATION 79.—Four miles north of Smoketown, above the Pennsylvania railroad crossing, East Lampeter Township, Lancaster County. Elevation 320–340 ft. Average width 147 ft. Average depth 2 ft. Shores pasture. Bedrock is dolomite. Stream bed mud. Considerable organic enrichment indicated by great abundance of *Oscillatoria princeps* and *Spirogyra* and the reduced fauna and flora of other groups.

STATION 70.—One mile above mouth of Mill Creek, West Lampeter Township, Lancaster County. Elevation 240 ft. Average width 62 ft. Average depth 4 ft. Banks steep, grass covered. Bedrock limestone. Stream bed mud and sand. Water carries a heavy silt load. Only more tolerant species present. Total bacterial count 1,750 per ml.

Little Conestoga Creek

STATION 169.—One and a quarter miles southeast of Manheim, Penn Township, Lancaster County. Elevation 440 ft. Average width 12 inches. Average depth 3 inches. Banks, grassy pasture, heavily enriched by cattle droppings. Bedrock Cocalico Shale. Stream bed rubble and mud. This station hard to classify as it is very narrow head water. Organic enrichment evidenced by common occurrence of *Spirogyra, Melosira varians* and *Nitzschia palea.* Total bacterial count 4,000 per ml.

STATION 63.—One and nine-tenths miles northwest on Harrisburg Pike from College Avenue, Lancaster, Hempfield Township, Lancaster County. Elevation 300 ft. Average width 18 ft. 8 inches. Average depth 12.5 inches. Banks pasture. Bedrock dolomite. Stream bed mud, detritus, and rubble. Indicators of pollution: abundance of algae, *Spirogyra, Melosira varians* and *Nitzschia palea;* and the tubificid worm, *Tubifex*. Total bacterial count 35,000 per ml.

STATION 5.—One-half mile north of junction of Little Conestoga with Conestoga Creek. Elevation 200 ft. Average width 75 ft. Average depth 14.5 inches. Banks grass and woods, somewhat eroded. Bedrock limestone. Stream bed silt and rocks. Indicators of organic pollution: *Oscillatoria, Spirogyra, Melosira varians* and *Nitzschia palea.* High total bacterial count, 99,000 per ml. B.O.D. 4.56 p.p.m.

Lititz Run Series

July Survey—Industries on Vacation

STATION 96.—Lititz Spring Run. In park, west side of Lititz, south of railroad, Warwick Township, Lancaster County. Elevation 380 ft. Average width 27 ft. Average depth 2 ft. 6 inches. A very artificial habitat, due to the fact that the stream bed and banks are concrete cinders. A large, cold, underground spring, which is the source of Lititz Spring Run, flows into this pool. The pool is stocked with trout. Considerable organic debris is thrown into the pool.

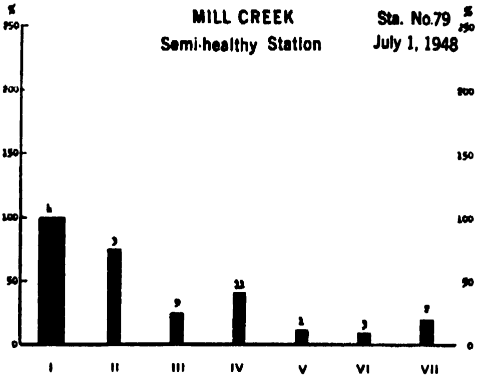

Fig. 37

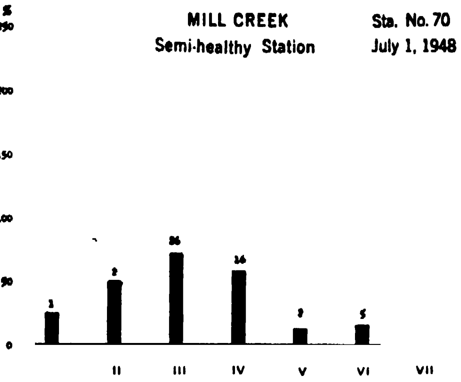

Fig. 38

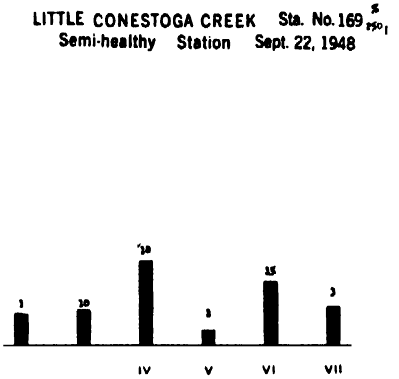

Fig. 39

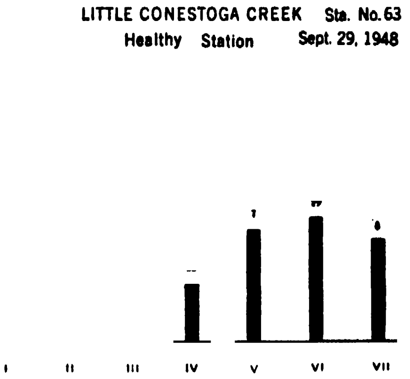

Fig. 40

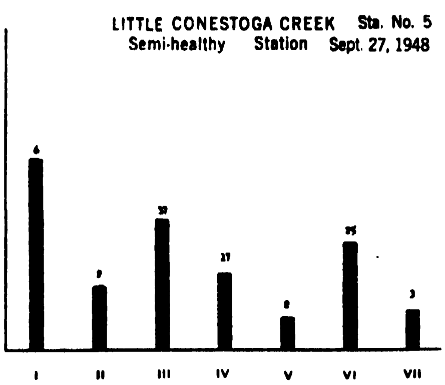

Fig. 41

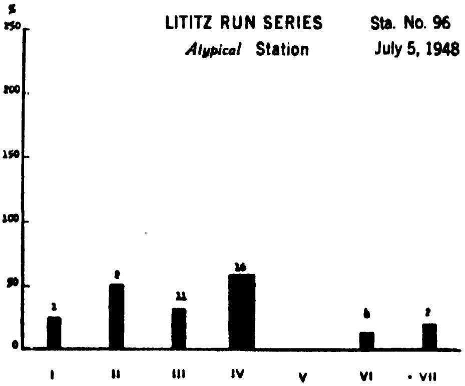

Fig. 42

Explanations on facing page

Lititz Run Series

July Survey—Industries on Vacation

(*continued*)

STATION 105.—Lititz Spring Run, south of the railroad and just east of Main Street, Warwick Township, Lancaster County. Effluent from Suchard Chocolate Factory and some sanitary waste enter just above this station. Bedrock limestone. Stream bed in upper part of station rubble, slag, etc. Lower part of station concrete. Polluted conditions indicated by great abundance of rotifer, *Cephalodella megacephala;* the protozoan, *Hexamitus inflatus;* the worms, *Limnodrilus* and *Tubifex;* the snail, *Physa heterostropha;* and the algae, *Tribonema vulgare, Spirogyra,* and *Nitzschia palea* and *Sphaerotilus.* Total bacterial count 6,100 per ml. Coliform count 21 per ml.

STATION 106.—One hundred feet above entrance of effluent of Pennsylvania Power and Light Company, Lititz Spring Run, Lititz, Warwick Township, Lancaster County. Elevation 360 ft. Average width 10 ft. 8 inches. Average depth 9.3 inches. Bedrock limestone. Stream bed boulders, gravel and sand. Banks grassy. Polluted conditions indicated by abundance of chironomids and occurrence of the rotifers *Chephalodella megacephala* and *Philodina citrina.* Total bacterial count 25,500 per ml. Coliform count 131 per ml.

STATION 107.—Lititz Spring Run, fifty feet below entrance of waste of Pennsylvania Power and Light Company. Elevation 360 ft. Average width 8 ft. 6 inches. Average depth 9.5 inches. Banks grassy. Bedrock limestone. Stream bed gravel, sand, and boulders. Polluted conditions indicated by absence of sensitive groups and abundance of *Tribonema vulgare, Stigeoclonium tenue,* and *Nitzschia palea.* Total bacterial count 30,000 per ml. Coliform count 43 per ml.

STATION 108.—Lititz Spring Run, fifty feet above confluence of Lititz Spring Run and Lititz Run. Average width 6 ft. Average depth 7.5 inches. Banks grassy. Very polluted condition indicated by lack of many groups of organisms and abundance of *Tribonema vulgare, Stigeoclonium tenue, Phormidium autumnale,* and *Nitzschia palea.* Total bacterial count 31,200 per ml. Coliform count 66 per ml.

STATION 111.—Lititz Run, eastern edge of Lititz, Warwick Township, Lancaster County. Elevation 360 ft. Average width 11 ft. 6 inches. Average depth 12 inches. Banks, grassy pasture. Indicators of pollution, lack of species in many groups.

STATION 110-A.—One mile east of Lititz, Warwick Township, Lancaster County. Elevation 340–360 ft. Average width 12 ft. 6 inches. Average depth 6 inches. Banks cut. Shore pasture. Indicators of pollution, very few species present with total absence of some groups. The algae *Stigeoclonium tenue, Tribonema vulgare,* and *Phormidium autumnale* were very abundant.

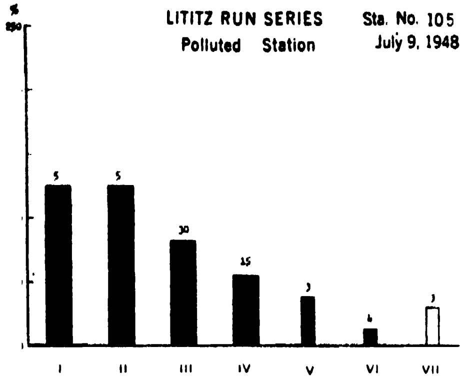

Fig. 43

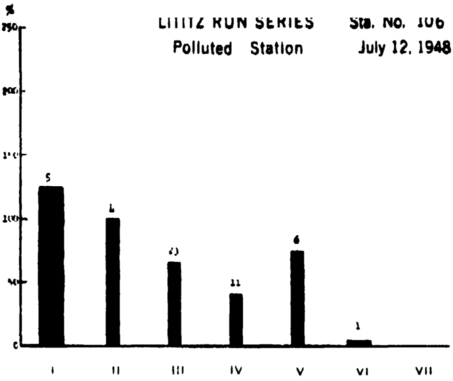

Fig. 44

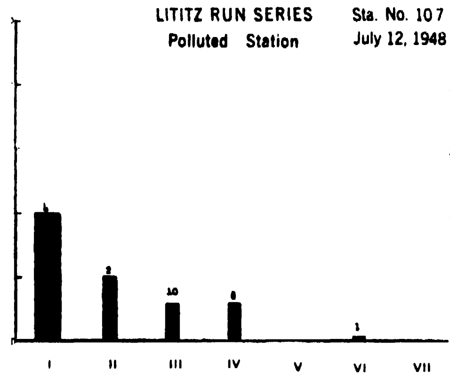

Fig. 45

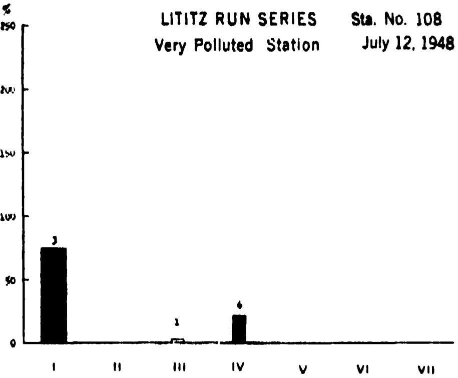

Fig. 46

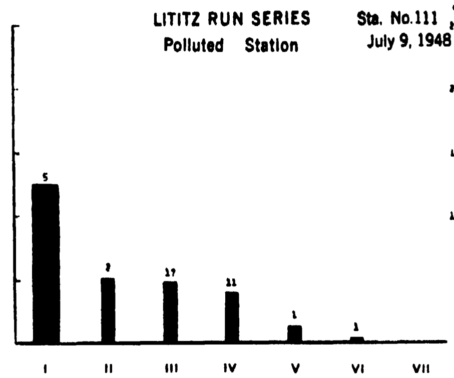

Fig. 47

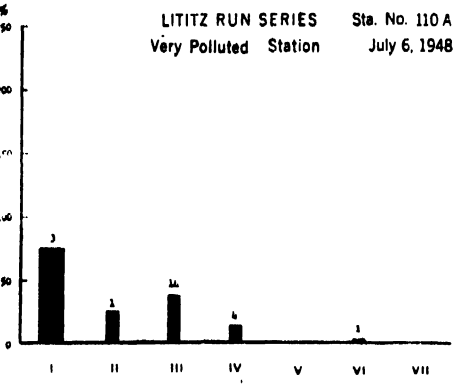

Fig. 48

Explanations on facing page

Lititz Run Series

July Survey—Industries on Vacation

(*continued*)

STATION 104.—Northwest of Disston, Warwick Township, Lancaster County. Elevation 320–340 ft. Average width 18 ft. 6 inches. Average depth 11 inches. Shores pasture land. Bedrock limestone. Stream bed sand and rubble. Pollution is indicated by the abundance of *Nitzschia palea, Tribonema vulgare, Stigeoclonium tenue, Phormidium autumnale,* and *Spirogyra;* and by the common occurrence of tubificid worms. Bacterial count, 4,460 per ml.

STATION 122.—At mouth of New Haven Run (Lititz Run Series), Manheim Township, Lancaster County. Average width 28 ft. Average depth 9 inches. Elevation 260 ft. Banks pasture. Bedrock limestone. Stream bed mud and rubble. Pollution was indicated by abundance of *Nitzschia palea, Stigeoclonium tenue, Spirogyra,* and various species of blue-green algae. Also by such protozoa as *Arcella vulgaris, Pleuronema crassum,* and *Spirostomum ambiguum;* and rotifers, *Philodina citrina* and *Cephalodella megacephala.* Total bacterial count 14,000 per ml. Coliform count 37 per ml.

Lititz Run Series

August—Low Water

STATION *96*.—Lititz Spring Run. In park, west side of Lititz, south of railroad, Warwick Township, Lancaster County. Elevation 380 ft. Average width 27 ft. Average depth 2 ft. 6 inches. A very artificial habitat due to the fact that the stream bed and banks are concrete cinders. A large cold underground spring which is the source of Lititz Spring Run flows into this pool. The pool is stocked with trout. Considerable organic debris is thrown into the pool. Total bacterial count 9,100 per ml. Coliform count 1 per ml. B.O.D. 1 p.p.m.

STATION *105*.—Lititz Spring Run, south of the railroad and just east of Main Street, Warwick Township, Lancaster County. Effluent from Suchard Chocolate factory and some sanitary wastes enter just above this station. Bedrock limestone. Stream bed in upper part of station rubble, slag, etc. Lower part of station concrete. Polluted conditions indicated by great abundance of the rotifer, *Cephalodella megacephala;* the protozoan, *Hexamitus inflatus;* the worms, *Limnodrilus* and *Tubifex;* the snail, *Physa heterostropha;* and the algae, *Tribonema vulgare, Spirogyra,* and *Nitzschia palea;* and *Sphaerotilus.* Total bacterial count 27,700 per ml. Coliform count 260 per ml. B.O.D. 7.9 p.p.m.

STATION *106*.—One hundred feet above entrance of effluent of Pennsylvania Power and Light Company, Lititz Spring Run, Lititz, Warwick Township, Lancaster County. Elevation 360 ft. Average width 10 ft. 8 inches. Average depth 9.3 inches. Bedrock limestone. Stream bed boulders, gravel, and sand. Banks grassy. Conditions more severe as evidenced by lack of sensitive rotifers and reduction in species of diatoms. B.O.D. 8.9 p.p.m.

STATION *107*.—Lititz Spring Run, fifty feet below entrance of waste of Pennsylvania Power and Light Company. Elevation 360 ft. Average width 8 ft. 6 inches. Average depth 9.5 inches. Banks grassy. Bedrock limestone. Stream bed gravel, sand, and boulders. Only abundant organisms *Stigeoclonium tenue, Phormidium autumnale,* and *Sphaerotilus.* B.O.D. 8.6 p.p.m.

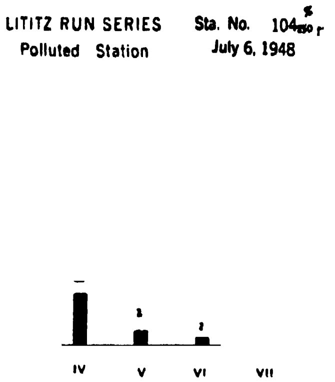
LITITZ RUN SERIES Sta. No. 104
Polluted Station July 6, 1948

Fig. 49

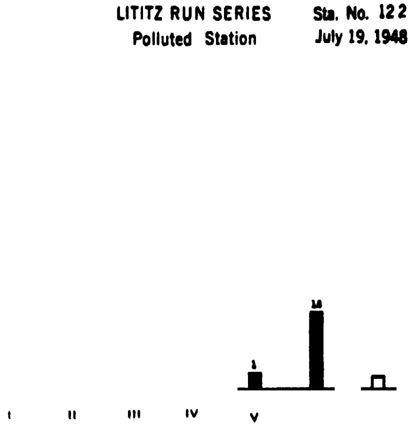
LITITZ RUN SERIES Sta. No. 122
Polluted Station July 19, 1948

Fig. 50

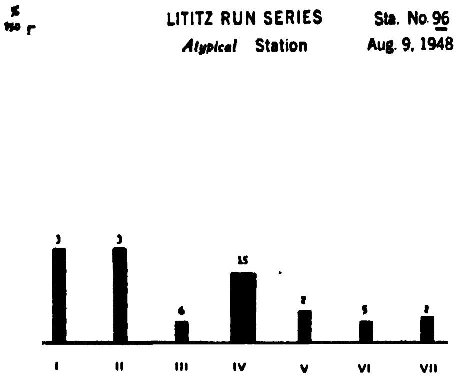
LITITZ RUN SERIES Sta. No 96
Atypical Station Aug. 9, 1948

Fig. 51

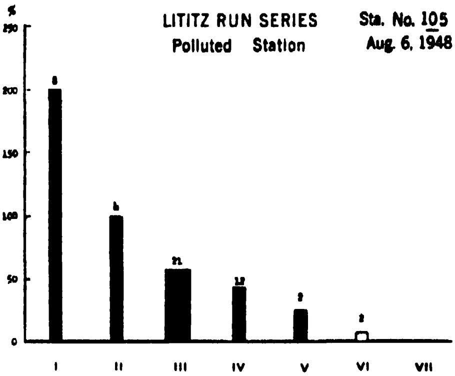
LITITZ RUN SERIES Sta. No. 105
Polluted Station Aug. 6, 1948

Fig. 52

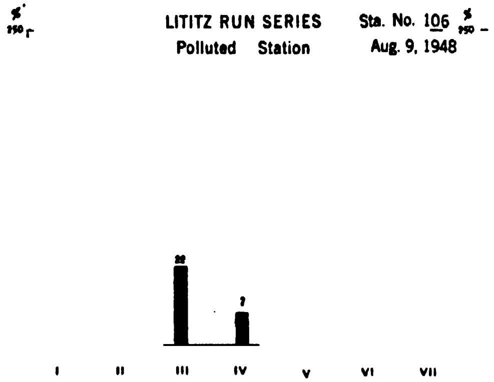
LITITZ RUN SERIES Sta. No. 106
Polluted Station Aug. 9, 1948

Fig. 53

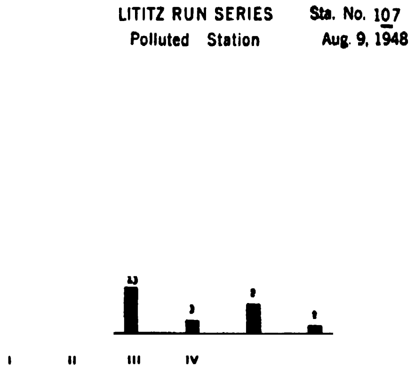
LITITZ RUN SERIES Sta. No. 107
Polluted Station Aug. 9, 1948

Fig. 54

Explanations on facing page

Lititz Run Series

August—Low Water

(*continued*)

STATION *108*.—Lititz Spring Run, fifty feet above confluence of Lititz Spring Run and Lititz Run. Average width 6 ft. Average depth 7.5 inches. Banks grassy. Very Polluted conditions indicated by lack of many groups of organisms and abundance of *Tribonema vulgare, Stigeoclonium tenue, Phormidium autumnale,* and *Nitzschia palea.* B.O.D. 7.35 p.p.m.

STATION *111*.—Eastern edge of Lititz, Warwick Township, Lancaster County. Elevation 360 ft. Average width 13 ft. Average depth 13 inches. Bedrock limestone. Stream bed gravel with some boulders. Most of the rocks were covered with *Sphaerotilus. Tribonema vulgare, Stigeoclonium tenue* and *Nitzschia palea* were common. The chemical analysis showed the nitrates to be very high. B.O.D. 3.8 p.p.m.

STATION *110*-A.—One mile east of Lititz, Warwick Township, Lancaster County. Elevation 340–360 ft. Average width 12 ft. 6 inches. Average depth 6 inches. Banks cut. Shore pasture. There is evidence of a greater degree of pollution, as more groups are absent.

STATION *122*.—At mouth of New Haven Run (Lititz Run Series), Manheim Township, Lancaster County. Average width 28 ft. Average depth 9 inches. Elevation 260 ft. Banks pasture. Bedrock limestone. Stream bed mud and rubble. Pollution was indicated by abundance of *Nitzschia palea, Stigeoclonium tenue, Spirogyra,* and various species of blue-green algae. Also by such protozoa as *Arcella vulgaris, Pleuronema crassum,* and *Spirostomum ambiguum;* and rotifers *Philodina citrina* and *Cephalodella megacephala.* Total bacterial count 8,000 per ml. Coliform count 222 per ml. B.O.D. 7 p.p.m.

Lititz Run Series

Fall Survey

STATION **96**.—Lititz Spring Run. In park, west side of Lititz, south of railroad, Warwick Township, Lancaster County. Elevation 380 ft. Average width 27 ft. Average depth 2 ft. 6 inches. A very artificial habitat due to fact that the stream bed and banks are concrete cinders. A large cold underground spring, which is the source of Lititz Spring Run, flows into this pool. The pool is stocked with trout. Considerable organic debris is thrown into the pool. The reason this station is included is that it is the headwater of Lititz Spring Run which is the most polluted stream of the basin. It is atypical as to ecological environment. The fish are artificially fed so that it is not supporting the apparent biodynamic cycle. A fair amount of organic pollution is present. Total bacterial count 8,300 per ml.

STATION **105**.—Lititz Spring Run, south of the railroad and just east of Main Street, Warwick Township, Lancaster County. Effluent from Suchard Chocolate Factory and some sanitary wastes enter just above this station. Bedrock limestone. Stream bed in upper part of station rubble, slag, etc. Lower part of station concrete. Polluted conditions indicated by great abundance of the rotifer, *Cephalodella megacephala;* the protozoan, *Hexamitus inflatus;* the worms, *Limnodrilus* and *Tubifex;* the snail, *Physa heterostropha;* and the algae. *Tribonema vulgare, Spirogyra,* and *Nitzschia palea* and *Sphaerotilus.* Total bacterial count 28,000 per ml.

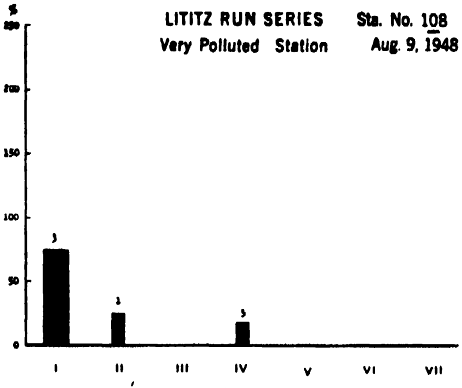

Fig. 55

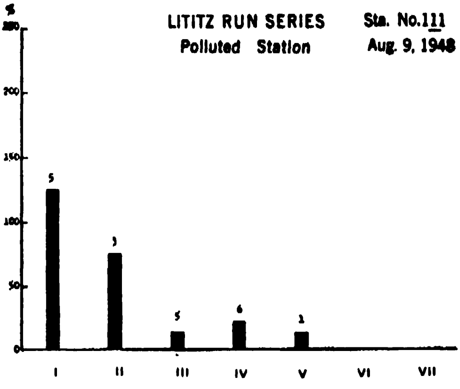

Fig. 56

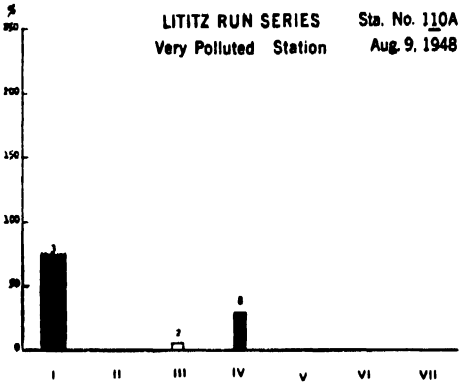

Fig. 57

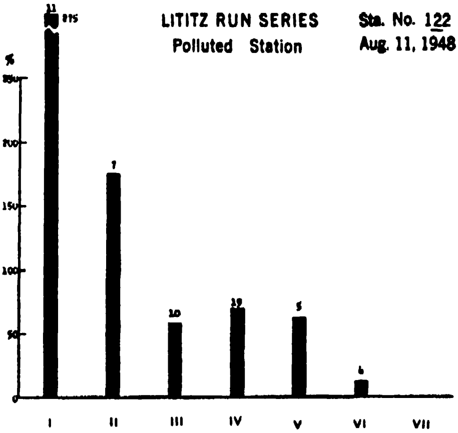

Fig. 58

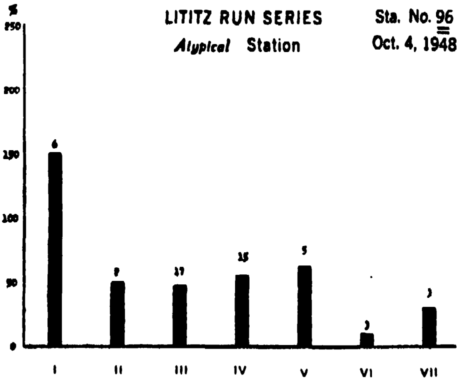

Fig. 59

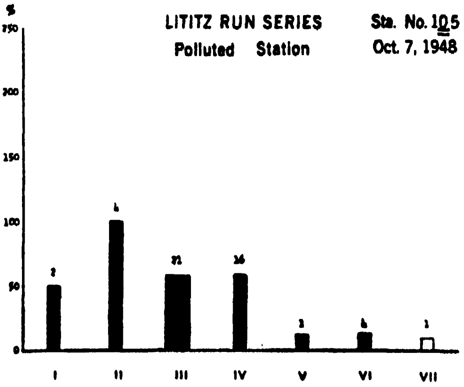

Fig. 60

Explanations on facing page

Lititz Run Series

Fall Survey

(*continued*)

STATION 106.—One hundred feet above entrance of effluent of Pennsylvania Power and Light Company, Lititz Spring Run, Lititz, Warwick Township, Lancaster County. Elevation 360 ft. Average width 10 ft. 8 inches. Average depth 9.3 inches. Bedrock limestone. Stream bed boulders, gravel, and sand. Banks grassy. Condition more severe, as evidenced by lack of sensitive rotifers, and reduction in species of diatoms. Total bacterial count 28,000 per ml. Low dissolved oxygen 4.7 p.p.m.

STATION 108.—Lititz Spring Run, fifty feet above confluence of Lititz Spring Run and Lititz Run. Average width 6 ft. Average depth 7.5 inches. Banks grassy. Very polluted conditions indicated by lack of many groups of organisms and abundance of *Tribonema vulgare, Stigeoclonium tenue, Phormidium autumnale,* and *Nitzschia palea.* Total bacterial count 35,000 per ml.

STATION 110-A.—One mile east of Lititz, Warwick Township, Lancaster County. Elevation 340–360 ft. Average width 12 ft. 6 inches. Average depth 6 inches. Banks cut. Shore pasture. There is evidence of a greater degree of pollution, as more groups are absent. Total bacterial count 53,000 per ml.

STATION 122.—At mouth of New Haven Run (Lititz Run Series), Manheim Township, Lancaster County. Average width 28 ft. Average depth 9 inches. Elevation 260 ft. Banks pasture. Bedrock limestone. Stream bed mud and rubble. Pollution was indicated by abundance of *Nitzschia palea, Stigeoclonium tenue, Spirogyra,* and various species of blue-green algae. Also by such protozoa as *Arcella vulgaris, Pleuronema crassum,* and *Spirostomum ambiguum;* and rotifers, *Philodina citrina* and *Cephalodella megacephala.* Total bacterial count 13,100 per ml. Some shift in species numbers is noticeable but the picture is the same.

Lititz Run Series

Lititz Run—Tributary

STATION 97.—Northeastern part of Lititz, Warwick Township, Lancaster County. Elevation 380 ft. Average width 4 ft. Average depth 9 inches. Bedrock limestone. Stream bottom rocks and mud and in part cement. Shores rocks and grass. Atypical owing to bridge debris which has been thrown in stream. This station is somewhat atypical owing to the bottom and banks of the stream. It represents a transitional stage between semi-healthy and polluted. Organic pollution is indicated by the common occurrence of *Spirogyra, Oscillatoria limosa, Tetraspora* sp., and tubificid worms.

STATION 98.—Northeast outskirts of Lititz, Warwick Township, Lancaster County. Elevation 380 ft. Average width 3 ft. 6 inches. Average depth 2 inches. Bedrock limestone. Stream bed fine shale and rubble. Banks steep, muddy. Organic pollution is indicated by the worms, *Tubifex* and *Limnodrilus;* the protozoa *Pleuronema crassum, Spirostomum ambiguum;* and the diatoms *Melosira varians* and *Nitzschia palea.*

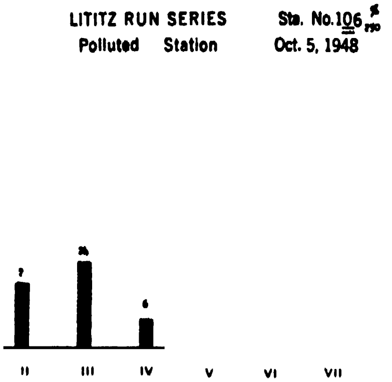

Fig. 61

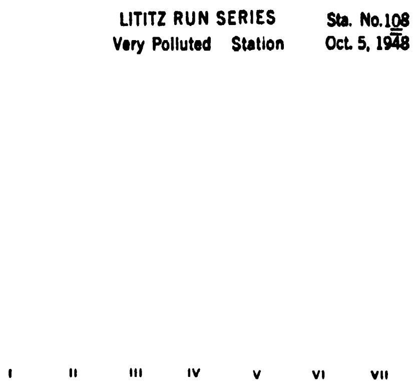

Fig. 62

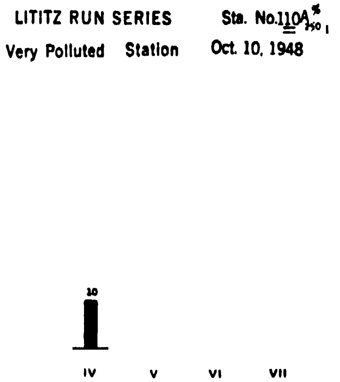

Fig. 63

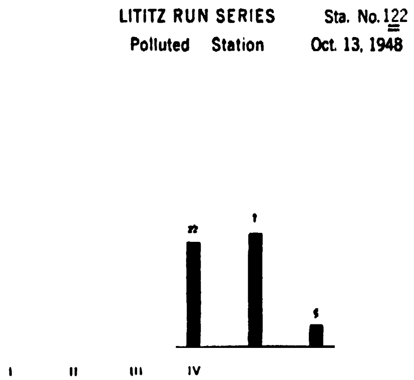

Fig. 64

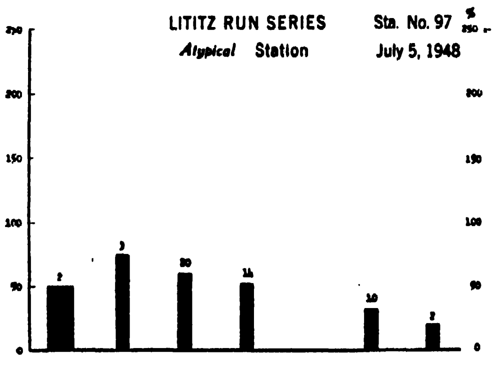

Fig. 65

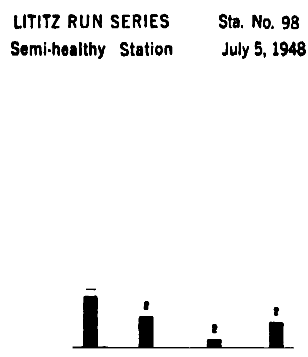

Fig. 66

Explanations on facing page

Lititz Run Series

Lititz Run—Tributary

(*continued*)

STATION 99.—At Lititz, just north of the Animal Trap Company, Warwick Township, Lancaster County. Elevation 380 ft. Average width 14.5 ft. Average depth 9.5 inches. Bedrock limestone. Stream bottom fine shale, mud, sand, and rubble. Right and left shores grassland. Organic pollution was indicated by the common occurrence of *Spirogyra* and the abundance of *Limnodrilus* and leeches. Bacterial count low, 750 per ml. Coliform count 29 per ml.

STATION 109.—East of the Animal Trap Company, Warwick Township, Lancaster County. Average width 14 ft. Average depth 9 inches. Bedrock limestone. Stream bottom mud, silt, and buried rocks. Indicators of pollution: worms, *Limnodrilus* and *Tubifex;* protozoa, *Coleps hirtus, Spirostomum ambiguum, Didinium nasutum, Colpidium colpoda;* the algae *Nitzschia palea* and various species of blue-green algae. Bacterial count 13,000 per ml. Coliform count 68 per ml.

Conestoga Creek

Early Summer Survey

STATION 18.—Three miles northeast of Lancaster, Manheim and East Lampeter Townships, Lancaster County. One hundred yards below entrance of effluent of Dean Mills. Elevation 280 ft. Average width 100 ft. Average depth 3 ft. Banks muddy, wooded. Bedrock limestone. Stream bed mostly mud, some gravel and boulders. Indicators of pollution: large number of worms and chironomids, abundance of *Oscillatoria limosa.*

STATION 16.—Below Lancaster Pumping Station, immediately below bridge, Lancaster Township, Lancaster County. Elevation 260 ft. Average width 136 ft. Average depth 2 ft. 6 inches. Banks muddy with some vegetation. Bedrock limestone. Stream bed stone, gravel, and mud. Sanitary wastes enter on right bank of stream at irregular intervals. Organic enrichment was indicated by abundance of certain species of protozoa, rotifers, blue-green algae and diatoms.

STATION 13.—Immediately below sewage disposal outlet, Lancaster Township, Lancaster County. Elevation 240 ft. Average width 17 ft. Average depth 2 ft. 7 inches. Banks steep, eroded. Heavy organic pollution indicated by algae, *Melosira varians, Nitzschia palea, Stigeoclonium tenue;* by worms, *Limnodrilus,* and leeches; by protozoa, *Hexamitus inflatus, Copromonas subtilis, Arcella vulgaris, Spirostomum intermedium,* and *Coleps hirtus.*

Conestoga Creek

August Survey—Low Water

STATION 20.—Manheim and Upper Leacock Townships, Lancaster County. Elevation 280 ft. Average width 159 ft. Average depth 13.5 inches. Banks grassy. Atypical eutrophic condition.

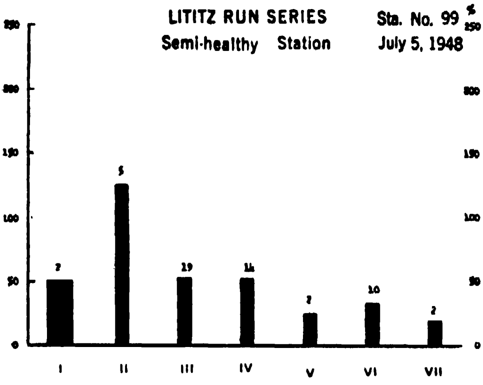

Fig. 67

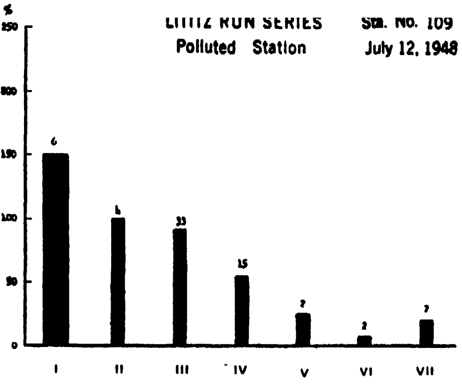

Fig. 68

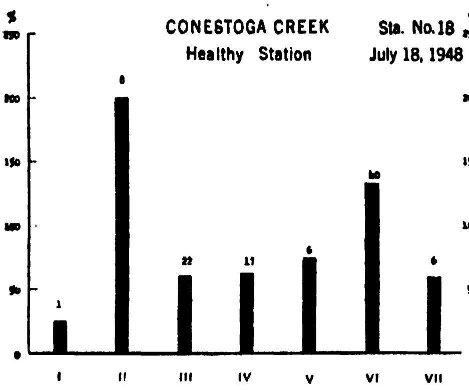

Fig. 69

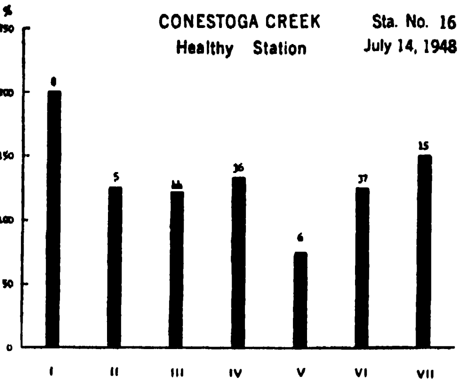

Fig. 70

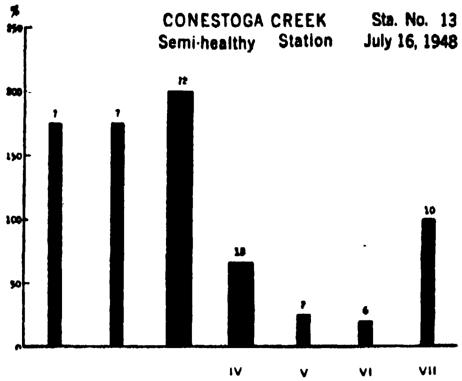

Fig. 71

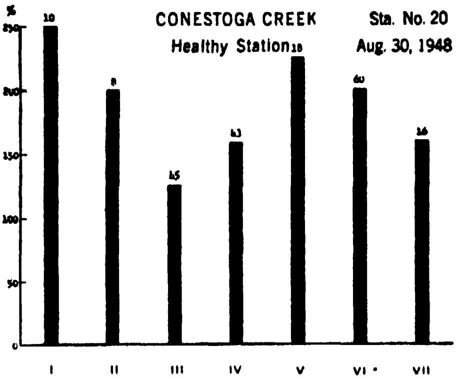

Fig. 72

Explanations on facing page

Conestoga Creek

August Survey—Low Water

(continued)

STATION *16*.—Below Lancaster Pumping Station, immediately below bridge, Lancaster Township, Lancaster County. Elevation 260 ft. Average width 136 ft. Average depth 2 ft. 6 inches. Banks muddy with some vegetation. Bedrock limestone. Stream bed stone, gravel, and mud. Not as many species as in July survey. An unusual abundance of insects. Total bacterial count near right bank of stream 2,820,000 per ml. Near left bank, 14,700 per ml. Sanitary wastes enter stream on right bank. B.O.D. 2.1 p.p.m.

STATION *18*.—Immediately below sewage disposal outlet. Lancaster Township, Lancaster County. Elevation 240 ft. Average width 17 ft. Average depth 2 ft. 7 inches. Banks steep, eroded. This station offers a great variety of habitats. Heavy organic pollution indicated by algae, *Melosira varians, Nitzschia palea, Stigeoclonium tenue;* by worms, *Limnodrilus,* and leeches; by protozoa, *Hexamitus inflatus, Copromonas subtilis, Arcella vulgaris, Spirostomum intermedium,* and *Coleps hirtus.* Total bacterial count varied in different parts of station from 36,700 per ml. to 322,600 per ml. Coliform count varied from 36 per ml. to 47 per ml.

Conestoga Creek

Fall Report

STATION *20*.—Manheim and Upper Leacock Townships, Lancaster County. Elevation 280 ft. Average width 159 ft. Average depth 13.5 inches. Banks grassy. This is an atypical eutrophic station. Total bacterial count is high, 25,000 per ml. The number of species in the various groups is not as high as in the summer survey. This may be in part due to the fact that at the summer sampling, this was a test station with two teams in the field. It may be due to seasonal change.

STATION 18.—Immediately below sewage disposal outlet, Lancaster Township, Lancaster County. Elevation 240 ft. Average width 17 ft. Average depth 2 ft. 7 inches. Banks steep, eroded. Depending on where the sample was taken the total bacterial count varied from 36,700 per ml. to 322,600 per ml. B.O.D. varied from 1.6–1.9 p.p.m.

STATION 9.—At covered bridge one-half mile southeast of Levans Mills, Lancaster Township, Lancaster County. Elevation 230 ft. Average width 67 ft. Average depth 21 inches. Shores, grass and woods, somewhat eroded. Bedrock limestone. Stream bed rubble and rocks. Low number of insects probably reflects sporadic pollution. Other pollution indicators: common occurrence of *Paramecium,* and tubificid worms; and the abundance of algae, *Oscillatoria, Stigeoclonium, Spirogyra, Melosira varians,* and *Nitzschia palea.* Total bacterial count 41,500 per ml.

CONESTOGA CREEK Sta. No. 16
Healthy Station Aug. 16, 1948

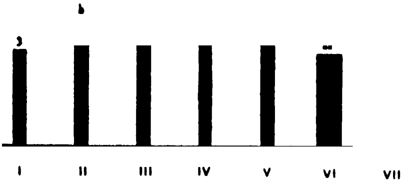

Fig. 73

CONESTOGA CREEK Sta. No. 13
Semi-healthy Station Aug. 18, 1948

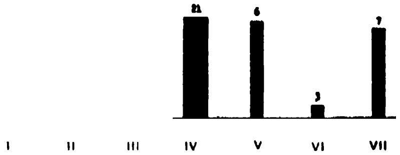

Fig. 74

CONESTOGA CREEK Sta. No. 20
Healthy Station Oct. 27, 1948

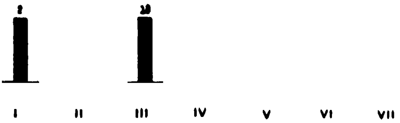

Fig. 75

CONESTOGA CREEK Sta. No. 13
Semi-healthy Station Oct. 25, 1948

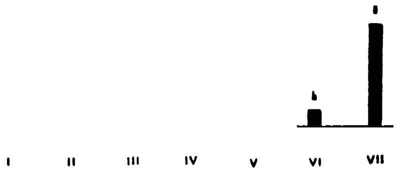

Fig. 76

CONESTOGA CREEK Sta. No. 9
Semi-healthy Station Sept. 7, 1948

Fig. 77

Explanations on facing page

APPENDIX 5

PERSONNEL OF BIOLOGICAL SURVEY

Director: H. Radclyffe Roberts

Limnologist in Charge: Ruth Patrick

Scientists

Algologists		
John L. Blum, Professor of Botany, Cassin College		June 15–Sept. 15
John H. Wallace, University of Pennsylvania		June 1–Sept. 15
Bacteriologists		
Donald Reihard, Jr., Pennsylvania State College	(half time)	June 15–Dec. 31
Raymond L. Smith, Pennsylvania State College	(half time)	June 15–Sept. 15
Entomologist		
John W. H. Rehn, Cornell University		June 15–Sept. 15
Invertebrate Zoologists		
Thomas Dolan, 4th, Cornell University		June 10–Dec. 31
Herbert W. Levi, University of Wisconsin		June 10–Sept. 15
Charles B. Wurtz, University of Pennsylvania		June 1–Dec. 31
Protozoologists		
John Cairns, University of Pennsylvania		June 10–Dec. 31
Dr. Mary Gojdics, Professor of Zoology, Beret College		June 15–Sept. 10
Vertebrate Zoologist		
James A. Jones, University of Minnesota		June 14–Sept. 15
Water Chemist		
John M. Ward, Rutgers University		June 4–Sept. 15
	(part time)	Sept. 15–Dec. 31

Scientific Consultants

Algologists

Dr. Francis Drouet, Curator of Cryptogamic Botany, Chicago Museum of Natural History

Dr. Gerald W. Prescott, Professor of Botany, State University of Michigan

Bacteriologist

Dr. Robert W. Stone, Pennsylvania State College

Chemists

Mr. Joseph Demann, Atlantic Refining Company
Dr. Roy Weston, Atlantic Refining Company

Entomologists

Dr. Philip P. Calvert, Research Fellow, Academy of Natural Sciences of Philadelphia
Dr. Herbért H. Ross, University of Illinois
Dr. Henry K. Townes, U. S. Department of Agriculture
Dr. Jay R. Travers, University of Massachusetts

Botanist

Dr. Norman C. Fassett, Professor of Botany, University of Wisconsin

Geologist

Dr. Jack B. Graham, District Geologist of the U. S. Geological Survey

Invertebrate Zoologists

Mr. Leonard M. Bennetch, Research Associate, Academy of Natural Sciences of Philadelphia
Dr. Libby Hyman, American Museum of Natural History
Dr. J. Percy Moore, Research Fellow, Academy of Natural Sciences of Philadelphia
Dr. Henry A. Pilsbry, Academy of Natural Sciences of Philadelphia

Limnologists

Dr. Arthur D. Hasler, University of Wisconsin
Dr. G. Evelyn Hutchinson, Yale University

Mycologist

Dr. Fred K. Sparrow, University of Michigan

Statistician

Dr. Ralph O. Erickson, University of Pennsylvania

Vertebrate Zoologists

Mr. Henry Fowler, Curator of Fish, Academy of Natural Sciences of Philadelphia
Dr. Ernest A. Lachner, Pennsylvania State College

Technicians and Assistants

Stuart S. Bamforth, Laboratory Assistant		June 15–Sept. 15
	(part time)	Sept. 15–Dec. 31
Hazel D. Barner, Laboratory Assistant		June 10–Sept. 15
	(part time)	Sept. 15–Dec. 31
James F. Bergseng, Field Assistant		June 15–Dec. 31
Edward Haldeman, Laboratory Assistant	(part time)	Sept. 15–Dec. 31
Robert L. Kane, Field Assistant		June 15–Sept. 15
Mariana F. Spangler, Secretary		Oct. 25–Dec. 31
Dorothy L. Wright, Laboratory Assistant		June 1–Dec. 31

ABSTRACT OF MINUTES OF THE ANNUAL MEETING OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA

February 15, 1949

One hundred and thirty-seventh Annual Meeting of the Academy.

Four hundred and fifty-three members and guests present.

President Charles M. B. Cadwalader in the Chair.

The Assistant Treasurer, John E. Bowers, presented a report covering the finances of the institution.

The Managing Director, H. Radclyffe Roberts, made a report for the year 1948, telling of the various activities of importance and programs under development. Among the more important topics discussed were the following:

The Board of Trustees created a new Department of Limnology with Dr. Ruth Patrick as Curator. Under contract with the Sanitary Water Board of the Commonwealth of Pennsylvania, this Department undertook a study of the Conestoga Creek in Lancaster County to determine a method of measuring stream conditions in terms of aquatic life. Sixteen scientists and assistants were employed during the summer for this study.

The Board of Trustees authorized the installation of a Limnology Laboratory to facilitate the work of that department. Gifts have been received to enable us to carry out this plan, and it is hoped to complete the installation within the next three months.

Concerning the activities of our other scientific departments, Dr. Henry A. Pilsbry completed the last volume of his monograph of the Land Shells of North America; Mr. James A. G. Rehn has completed the first section of his report on the Orthoptera of Australia, which he is undertaking in cooperation with the Australian Government. Mr. Rodolphe M. de Schauensee has just completed a comprehensive treatment of the Birds of Colombia which is being published in Colombia.

Among the expeditions sent out by the Academy, Dr. Pilsbry and Dr. Pennell spent five months in Peru collecting materials in their respective fields. Dr. Horace G. Richards visited the Mackenzie Delta in Arctic Canada to obtain fossils and geological information. Mr. William K. Carpenter, accompanied by Mr. Harold T. Green, spent six months across central Africa and obtained materials for a desert sheep habitat group, and very fine colored motion pictures. Mr. Cummins Catherwood and Mr. Charles G. Chaplin took four of our scientists to the West Indies to study the flora and fauna of Cayo Largo, Old Providence, and St. Andrews Islands for a period of six weeks last spring.

Plans were presented for an expansion of our educational program for the schools.

During the year 200 new members were added to our membership role with a net increase of 47 members. Our present membership stands at 2200.

The next order of business was the election of Trustees. The following individuals were nominated, as prescribed by the By-Laws of the Academy, and elected to the Board of Trustees for a period extending to the Annual Meeting, 1952: Charles M. B. Cadwalader, Rodolphe M. de Schauensee, Richard L. Davies, Henry S. Drinker, W. B. Hart, H. Radclyffe Roberts.

Following the election of the Trustees, Managing Director Roberts introduced Mr. Cummins Catherwood, who showed the colored motion pictures taken on the Catherwood-Chaplin West Indies Expedition and commented on the expedition and pictures. Following this, Dr. Roberts invited the members and guests present to see the paintings done by Mr. Rodolphe C. Von Ripper, a member of the expedition, which were on view in the Hall of Changing Exhibits.

ELECTION OF OFFICERS

At a meeting of the Board of Trustees of the Academy held March 16, 1949, the following officers were elected:

President: Charles M. B. Cadwalader

Vice-President: Edwin G. Conklin

Vice-President: R. Meyer de Schauensee

Managing Director: H. Radclyffe Roberts

Treasurer: Brandon Barringer

Secretary and Assistant Treasurer: John E. Bowers

Corresponding Secretary: James A. G. Rehn

FROM THE MINUTES OF THE BOARD OF TRUSTEES

FRANK JAMES KEELEY

Mr. Keeley was born on January 6, 1868, and died on April 13, 1949. He was educated at the University of Pennsylvania from which he received the B.S. degree in 1887 and the E.M. degree in 1888. While a student there he was an ardent football player.

In 1892 he joined his father's mining firm, Jerome Keeley and Company.

From the time of his becoming a life-member of the Academy of Natural Sciences of Philadelphia in 1894, Mr. Keeley took a keen interest in its activities. He became at various times Conservator of the Biological and Microscopical Section, Vice-Director of the Mineralogical and Geological Section, Curator of the William S. Vaux Collection, Associate Curator of the Microscopical Section, member of the Board of Trustees and on its executive committee, and a member of the Scientific Council.

Mr. Keeley was known throughout the United States as a naturalist. His particular interest lay in the field of microscopical objects—minerals, and diatoms. He described two new minerals, Lansfordite and Nesquehonite. During his lifetime he accumulated what is thought to have been the finest collection of micro-minerals in the World. His work on the structure of the diatom wall is considered today the most authoritative in the field. He assembled a large collection of microscopes, and he was a Fellow of the Royal Microscopical Society of London.

Mr. Keeley was one of the few great general naturalists left in this country and his passing will be a great loss to the Academy and to the Philadelphia community.

DR. THOMAS SUMMERVILLE STEWART

Dr. Stewart, who was curator of the Microscopical Department of the Academy of Natural Sciences, died on February 19, 1949, after a series of heart attacks which started on New Year's Eve, 1948.

Dr. Stewart was born in Philadelphia. He was educated at the University of Pennsylvania receiving an A.B. degree in 1895, and his M.D. in 1904.

In the field of medicine his main interest was the x-ray. He, with Dr. C. L. Leonard were the first to bring x-ray to this country. In conjunction with Dr. Leonard and others, he was among the first to experiment as to its various uses. His interest in x-ray led him to become a charter member of the Philadelphia Roentgen Ray Society, and for over fifty years, a member of the Franklin Institute.

His main interest during the last half of his life was the microscope and the photographing of objects seen through it. He accumulated one of the best private collections of microscopes in the country. Some of his photomicrographs, particularly of diatoms, were from the standpoint of resolution, the best which have ever been made. He often exhibited them at the expositions of the New York Microscopical Society.

Dr. Stewart became a member of the Academy of Natural Sciences in 1900. He took an active interest in its affairs, being Curator of the Microscopical Department, a member of the Scientific Council, and a member of the Photographic Committee.

His interest in the microscope caused him to join several scientific societies. He was a Fellow of the Royal Microscopical Society of London, Vice-President and Treasurer of the Leidy Microscopical Society, member of the American Microscopical Society and the American Association for the Advancement of Science.

Dr. Stewart was not only revered as an authority on the optics of the microscope, but valued as a sincere friend by those who knew him. The importance of his contribution to the development of x-ray can hardly be estimated, for he was one of that first group who developed a novel scientific discovery into a powerful tool of medicine.

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